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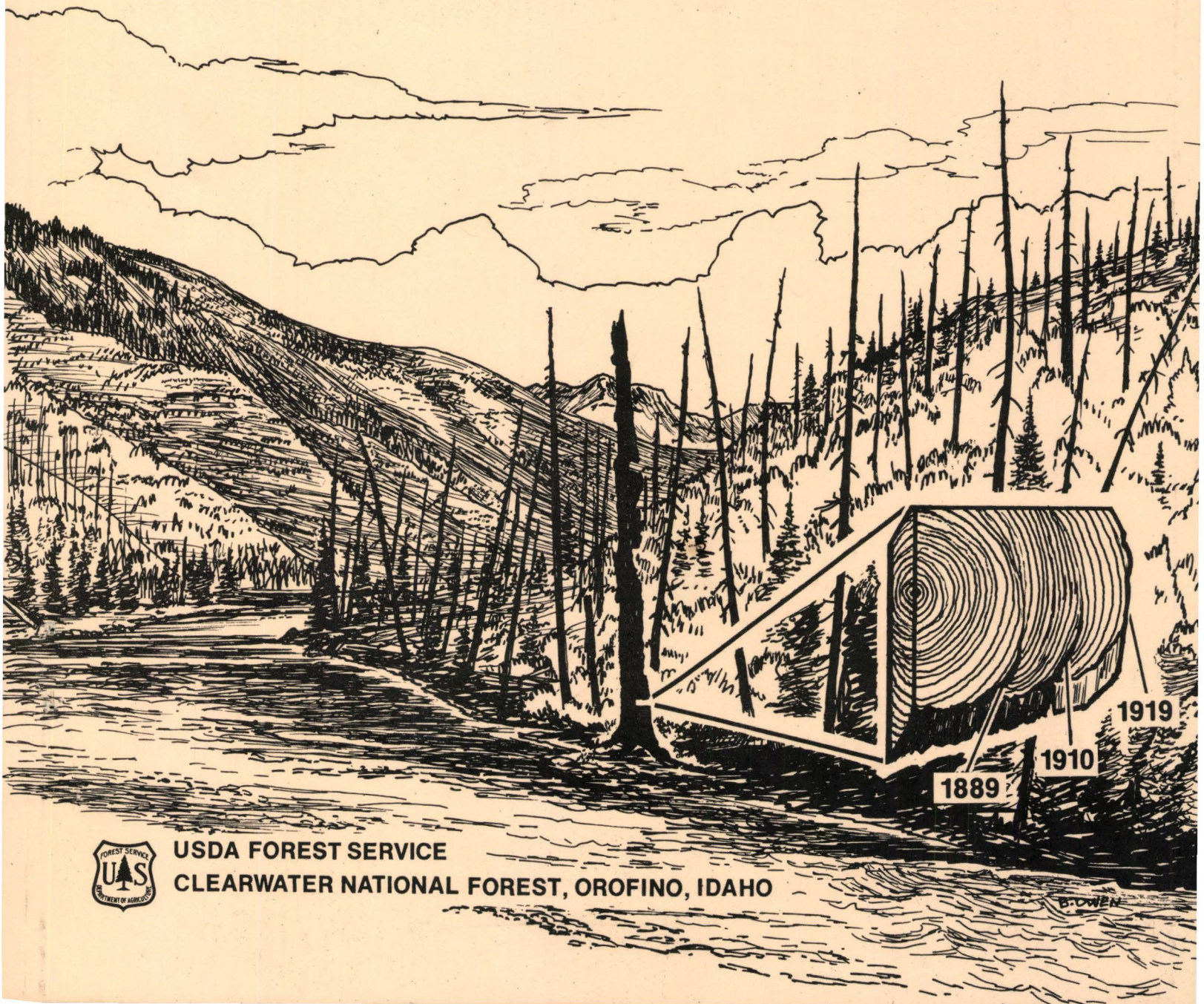
Fire's Influence on Ecosystems Of the Clearwater National Forest:

Cook Mountain Fire History Inventory

Stephen W. Barrett



USDA FOREST SERVICE
CLEARWATER NATIONAL FOREST, OROFINO, IDAHO

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FIRE'S INFLUENCE ON ECOSYSTEMS OF THE CLEARWATER NATIONAL FOREST:

COOK MOUNTAIN FIRE HISTORY INVENTORY

Stephen W. Barrett

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USDA Forest Service
Clearwater National Forest
Fire Management
Orofino, Idaho

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INTRODUCTION

Few events in the history of American forestry are as notorious as the "Great Idaho Fire of 1910." A combination of severe drought and the onset of numerous uncontrolled lightning fires over many weeks allowed a "big blowup" to occur on August 20th, when gale force winds forced many fires to converge and intensify to holocaustic proportions (Koch undated). Two days later, rain and cool temperatures halted the major advance but the holocaust's toll was 85 lives and approximately 3 million forested acres in northern Idaho and western Montana (fig. 1).

Although less well known, a number of other very severe fire years occurred in northern Idaho after 1910. Perhaps the best example is on the Clearwater National Forest (CNF), where tens of thousands of acres were burned in 1919, 1926, 1928, and 1934 (Gisborne 1932, Space 1979) (fig. 2). Large expanses reburned multiple times throughout the short period, often resulting in shrubfields that today have persisted for five or six decades.

Northern Idaho contains some of the most productive forest habitat types in Region 1 but this potential is not being realized on many National Forest sites because of these conflagrations. The past role of fire in northern Idaho's forests has not been well documented. National Forest land use planning requires input on this historical role and fire history data are necessary to describe the fire frequencies, intensities, and ecosystem responses that were characteristic before the advent of organized fire suppression. During the summer of 1981, a fire history inventory was initiated by the CNF to provide this information to managers and forest planners.

OBJECTIVES

The objectives were as follows:

1. To inventory the fire history of the Cook Mountain study area (Kelly Creek Ranger District) (figs. 1, 2), using fire scars to date and map historic fires larger than 1,000 acres and calculate mean fire frequencies for each forest type.

2. To make interpretations about fire effects on stand composition, structure, and succession based on plot data and fire frequencies.

3. To identify tree regeneration potential on the most severely burned sites and help identify management options for such areas.

4. To apply interpretations to other aspects of forest management, such as soils, fire, and wildlife.

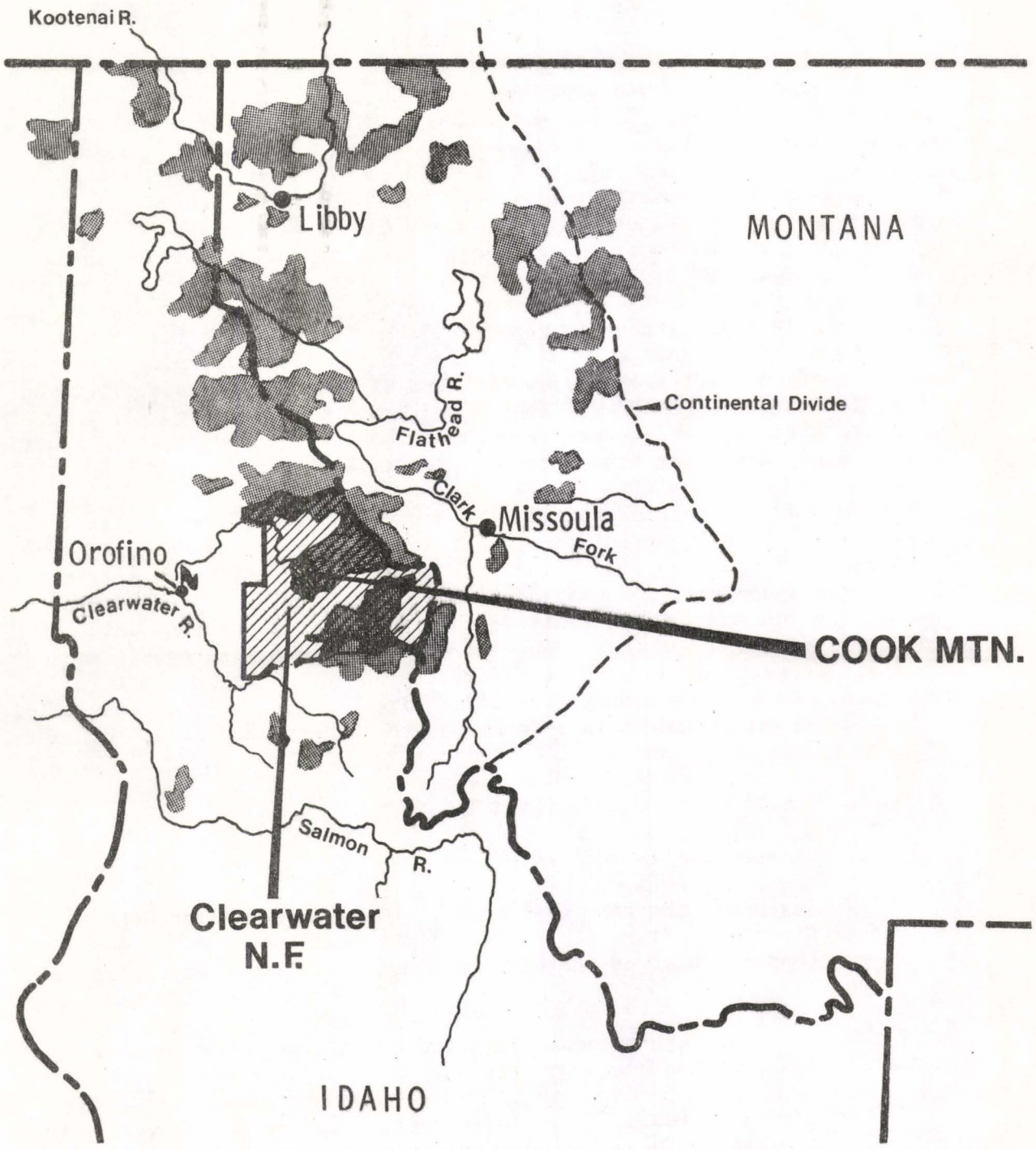


Fig. 1 -- General extent of the 1910 forest fire in northern Idaho and western Montana. (after: Koch [undated] and Wellner [1965])

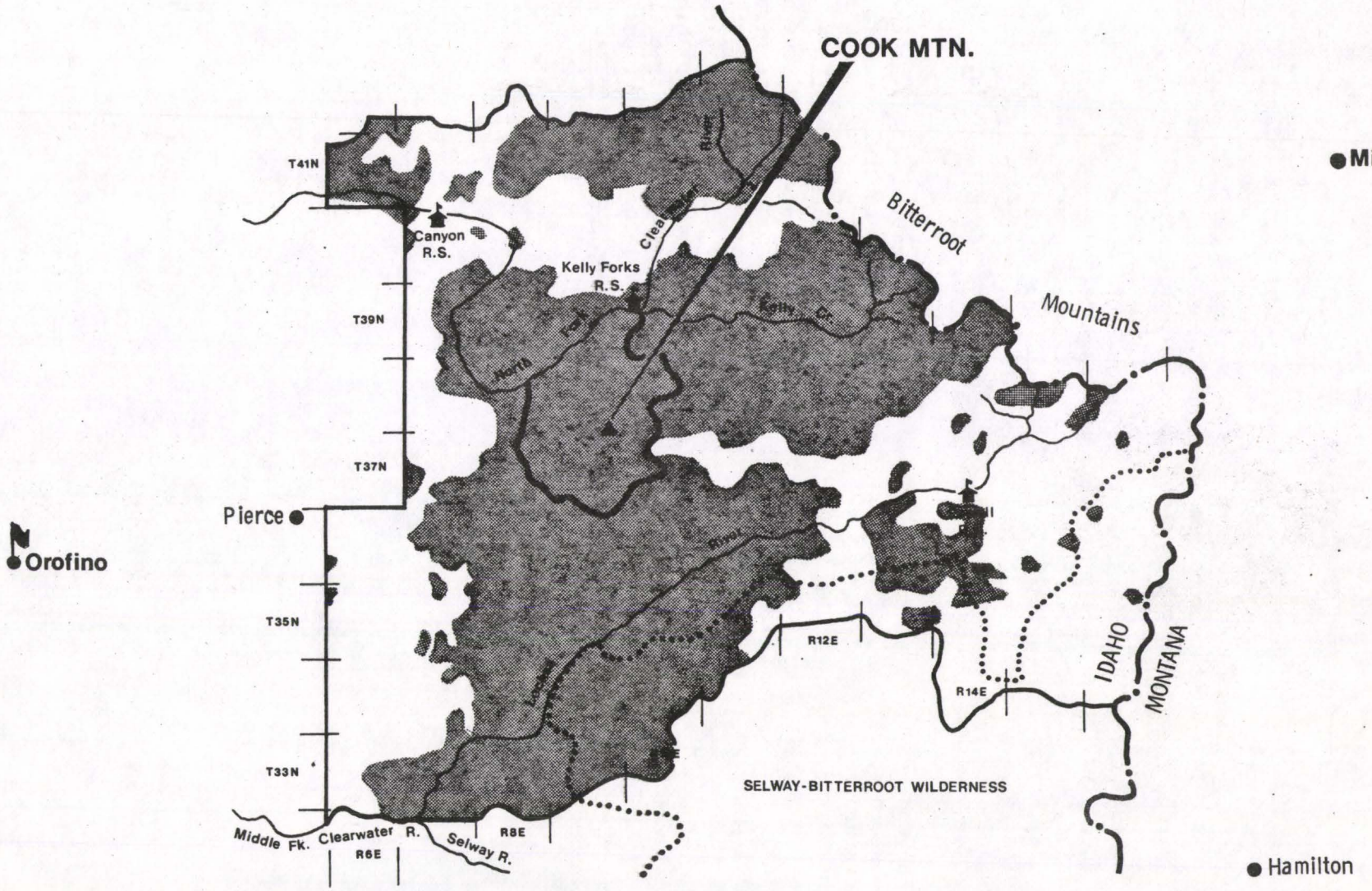


Fig. 2 -- Clearwater National Forest burned area map, 1910-1940.
(source: maps on file, CNF Fire Management)

STUDY AREA

Under the direction of CNF Fire Staff Officer Gary Meyer, the approximately 83,000-acre Cook Mountain study area was selected as representative of most CNF forest types and severely burned areas (fig. 3). The initial goal of the CNF staff was to inventory fire history on a Forest-wide scale; however, limited resources dictated the selection of a smaller study area for more-intensive analysis. The Cook Mountain area was particularly appropriate for this investigation because repeated intensive reforestation efforts since 1963, representing an investment of more than $500,000, generally have resulted in poor regeneration success. As part of the effort to protect this investment a fire history inventory was considered to be a valuable asset contributing to the forthcoming Cook Mountain Management Plan.

The 1981 CNF report "An Analysis of Regeneration Potential of the Cook Mountain Analysis Area, Kelly Creek Ranger District," describes in detail the vegetation, soils, and other physical characteristics of the study area; therefore only a brief summary of factors important in the fire history analysis are included below. District fire maps generally portray fire occurrence back to about 1900, providing baseline data important for this inventory.

The Cook Mountain study area (2,370-6,876 ft elevation) occupies the northwestern border zone of the Idaho Batholith. Soils generally consist of well-drained decomposed granite, often highly erodable. Most soils are capped by a Mt. Mazama ash layer 10 to 20 inches deep, giving most sites their moderate-high site quality rating. The majority of the study area's vegetation falls into three associations described by Daubenmire and Daubenmire (1968) (fig. 4): (1) western redcedar/pachistima (Thuja plicata/Pachistima myrsinites) habitat type, from about 2,400 to 5,000 ft maximum study area range; (2) grand fir/pachistima (Abies grandis/Pachistima myrsinites) habitat type, from about 3,000 to 5,200 ft; and (3) subalpine fir (Abies lasiocarpa) habitat types, from about 5,000 to 6,900 ft (the subalpine habitat types include Abies lasiocarpa/Pachistima myrsinites, Abies lasiocarpa/Menziesia ferruginea, Abies lasiocarpa/Xerophyllum tenax, and small portions of Tsuga mertensiana/Xerophyllum tenax).

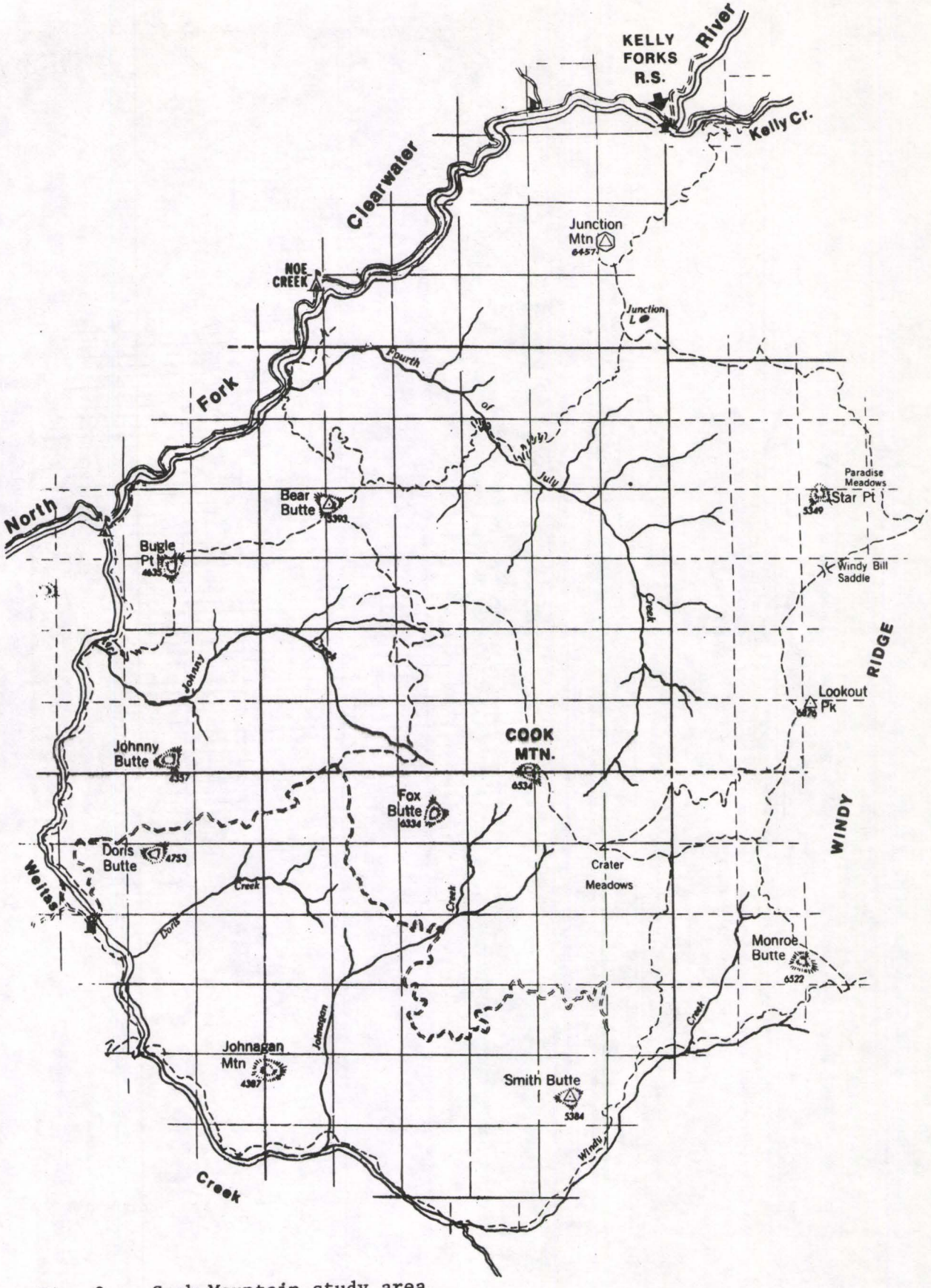


Fig. 3 -- Cook Mountain study area.

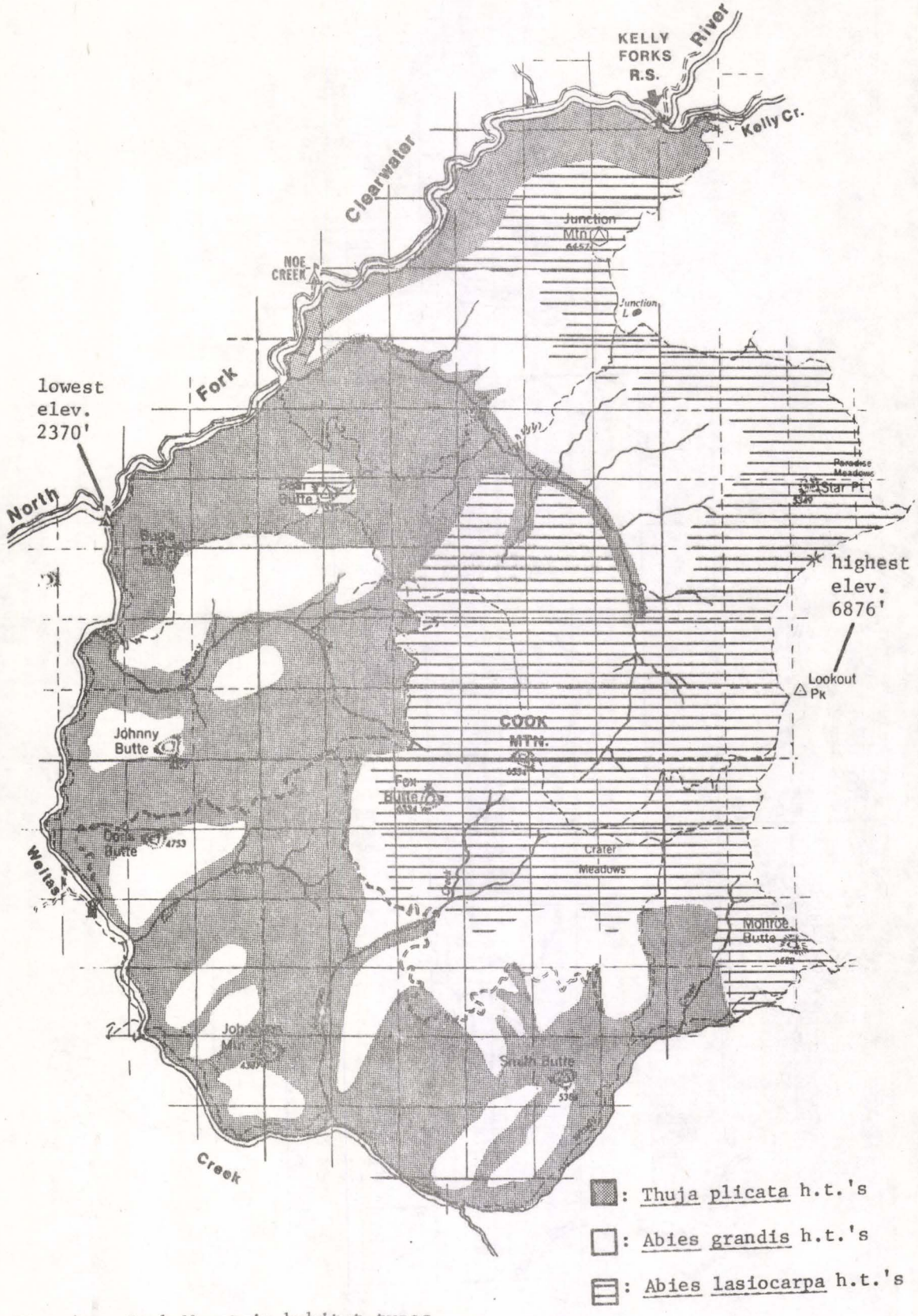


Fig. 4 -- Cook Mountain habitat types.

Like many other areas of the CNF, most of Cook Mountain has been severely deforested by repeated fires (figs. 5, 6, 7), or nearly 56,000 acres (∿68 percent of the study area). Shrubfields are the primary communities below about 5,200 ft and these are variously dominated by tall shrubs such as willow (Salix scouleriana), shiny-leafed ceanothus (Ceanothus velutinus), mountain maple (Acer glabrum), with associated lower shrubs such as serviceberry (Amelanchier alnifolia), redstem ceanothus (Ceanothus sanguineus), pachistima (Pachistima myrsinites), white spirea (Spirea betulifolia), snowberry (Symphoricarpos albus), menziesia (Menziesia ferruginea), or ninebark (Physocarpus malvaceus). In the herb layer many species of graminoids (often dominated by elk sedge [Carex geyeri] and pinegrass [Calamagrostis rubescens]), or bracken fern (Pteridium aquilinum), can form pure stands at lower elevations. Subalpine deforested areas usually are dominated by beargrass (Xerophyllum tenax) or menziesia.

Most forests in the study area (only about 27,000 acres) are less than 60 years old, having originated after the holocaustic 1919 fire. (This fire burned more than 300,000 acres on the CNF.) The study area's forests generally are limited to (1) uneven-aged riparian stands of cedar and grand fir (fig. 8), with scattered remnants up to several hundred years old; (2) north or west slope, mid-elevation stands of even-aged western larch (Larix occidentalis), or uneven-aged climax tolerants, primarily cedar, and grand fir and Douglas-fir (Pseudotsuga menziesii), with scattered individuals up to about 250 years; and (3) upper-elevation, even-aged stands of lodgepole pine (Pinus contorta) (fig. 9) or uneven-aged, climax tolerants subalpine fir or mountain hemlock, most less than 60 years old.

Fig. 5 -- Second decade of succession after the 1919 fire, North Fork of the Clearwater River below the mouth of Kelly Creek (August 1941). In 1982 shrubfields often still dominated all but the north slope riparian bottoms.

Fig. 6 -- Upper slopes of Cook Mountain 2 years after the 1910/1919 double burn (August 1921). Primary habitat types probably are subalpine fir/menziesia and /beargrass.

Fig. 7 -- Looking northwest across Shot Creek toward Junction Mountain 6 years after the 1910/1919 double burn (October 1925). Primary habitat types probably are subalpine fir/beargrass and /menziesia.

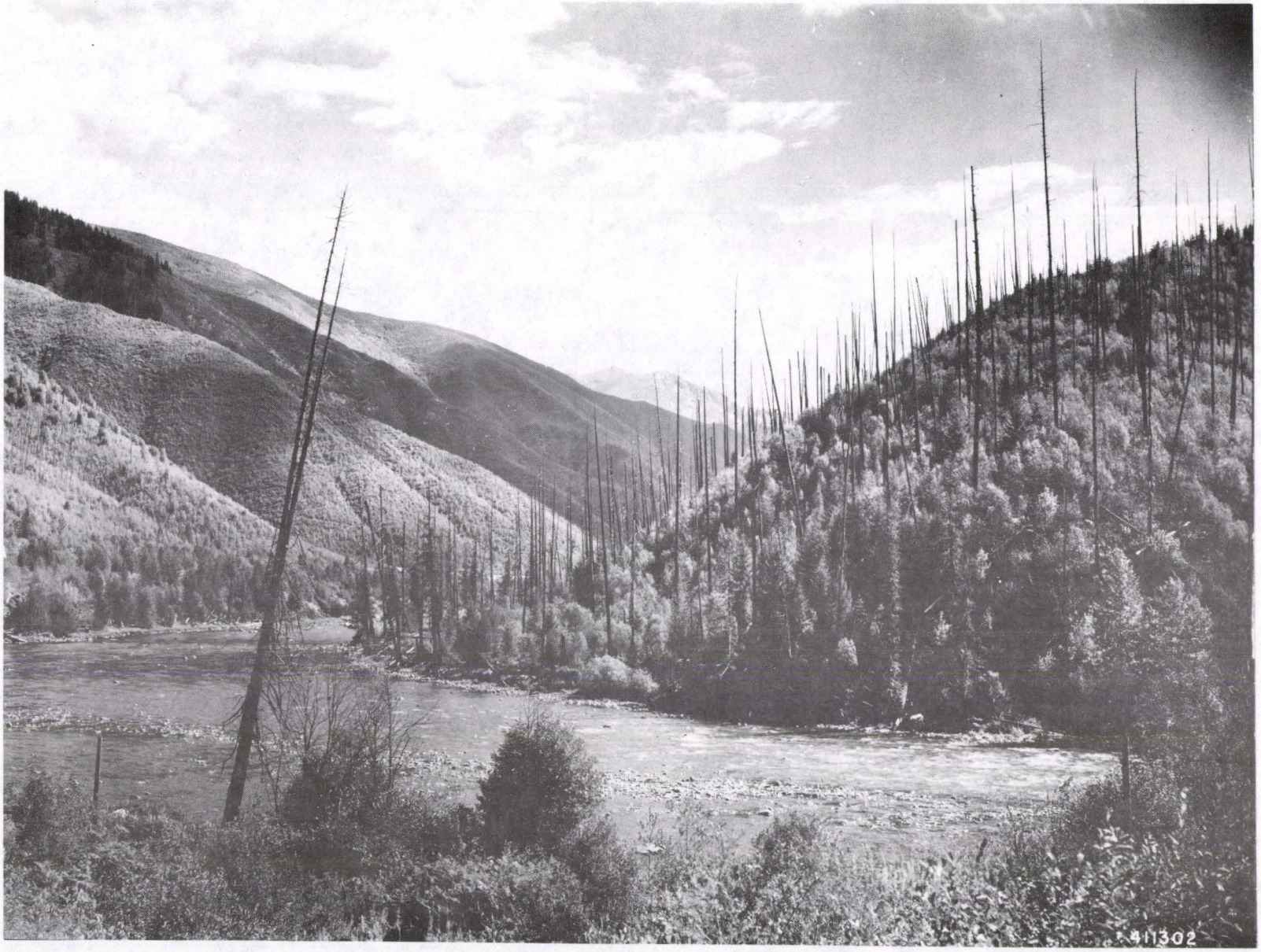


Fig. 8 -- North Fork of the Clearwater River near Gilfillian Cr. (August 1941). Post-1919 north slope regeneration (right) consists of well stocked larch, grand fir, Douglas-fir, and western redcedar. These same south slopes (left) still were nonstocked in 1982.

Fig. 9 -- Lodgepole pine regeneration beginning to overtop low-growing shrubs 11 years after the 1910 fire, northeast subalpine slopes of Lookout Peak (October 1921).

METHODS

The methods of Arno and Sneck (1977) were used in which transects were coursed across all elevations, aspects, and habitat types to obtain fire scars in cluster patterns. Most transects were located along available roads and trails (fig. 10). Sample cross-sections were sanded and dated with the aid of a microscope, followed by construction of un-crossdated master fire chronologies for the study area and for selected stands in each forest type. Mean fire intervals (MFI's), or average interval lengths between fires, were then calculated.

Habitat type plots (approximately 375 m^2) were taken in representative stands along the transects. Stand structure was characterized for each plot by recording tree species by d.b.h. class, canopy coverage, and age class. Stand table graphs were constructed by displaying each species according to the above parameters in order to analyze stand structure and postfire regeneration.

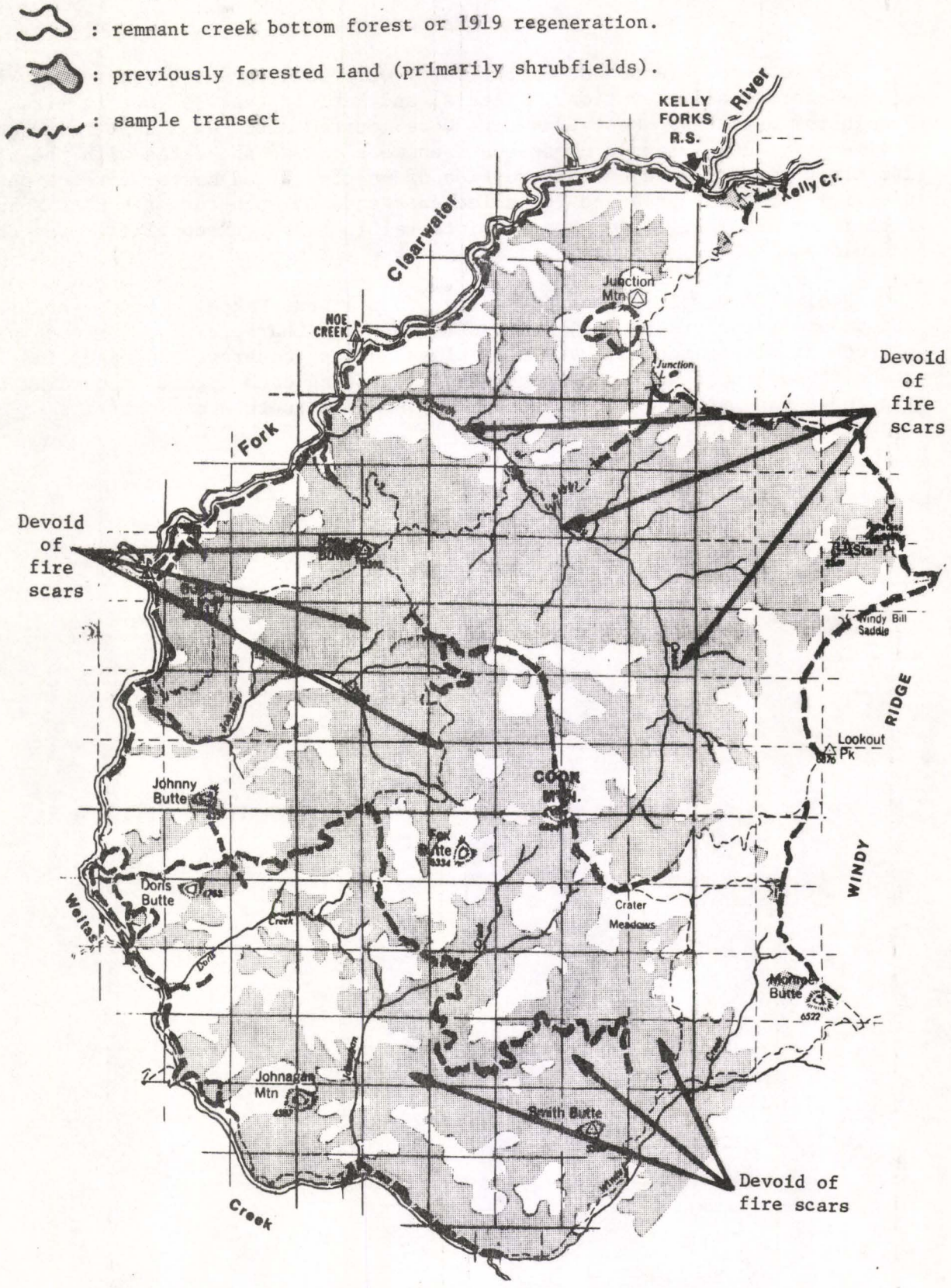


Fig.10 -- Cook Mt. cover types relative to fire history sampling.

RESULTS

Cook Mountain Fire History, 1680-1981

A relatively unbroken fire chronology was established back to 1680, with the earliest nonsequential fire occurring about 1535. Twenty-five major fire years were identified from 1535 to 1928, which was the last fire of any consequence in the Cook Mountain area. Because of the severe deforestation and paucity of old growth, it was necessary to rely on snags of trees killed by the 1910 or 1919 fires for the majority of the 335 samples (72 percent). Most snag samples were from western redcedar, larch, lodgepole pine, or subalpine fir. These species made excellent quality samples, the snags often being preserved by pitch and withstanding at least six decades of weathering.

Unlike most other fire history investigations, extreme fire dating problems were encountered which slowed the laboratory process considerably. For example, it was necessary to estimate snag death years and this was complicated by the occurrence of the last two major fires within just 9 years of each other (1910 and 1919); these fires also occurred within close geographic proximity of each other and the burn margins usually overlapped. (After intensive field investigations the assumption was made that all sample snags were from fires which occurred after 1910, snags from earlier fires having been largely decomposed.) Snag death years were estimated only after compiling evidence from old district fire maps, snag cambial surfaces (charring vs. un-reburned gray surfaces), increment cores from surrounding fire-initiated age classes, and from ring counts back to the benchmark 1889 fire scar, if present. A second troublesome problem was that imprecise scar dates often were obtained from cluster samples which appeared to have been scarred by the same large fire. These were caused by (1) occasional false rings on cedar samples, usually occurring near the fire scar; (2) surprisingly uniform-appearing erosion of rings from around the circumference of snags (not detected in the field); (3) occasional cedar root rot scars (Arno and Davis 1980); (4) the suspected tendency of some trees to have died not until several years after the lethal 1910 or 1919 fires (thus causing discrepancies among nearby similar scar dates), or (5) scar dating also may have been confounded by early scars from ungulate antler rubbings (small groups of trees less than 10" d.b.h. often were observed to have been recently scarred by ungulates, especially in lodgepole pine stands). Many samples eventually had to be discarded because they were suspected of being sources of misinformation. However, sources of error were reduced by obtaining multiple samples in clusters and by mapping only those fires larger than 1,000 acres, essentially ignoring all suspiciously frequent, disjunct-dated scars not verified by at least five nearby trees. Because of these problems a lesser degree of scar dating accuracy can be expected; therefore, most fire dates before the known 1889 fire should be considered only close approximations (probably within a liberal range of ±3 years).

Fire mapping also was difficult because of the long-term, widespread destruction of fire scar sources and age classes. Although it was not possible to map fires precisely, large-scale estimates are provided based largely on scar sample locations coordinated with the likely topographic pathways of large fires.

Results indicate that conflagrations were not limited to just the 1910-34 period. Large stand-replacing fires exceeding 1,000 acres occurred somewhere in the study area at a frequent rate of about every 10 years from 1680 to 1928, a number of them reburns. Even more remarkable is that major fires exceeding 10,000 acres apparently occurred every 25-31 years during the same 248-year period (table 1). Some of these very possibly were holocaustic fires comparable to those in 1910 or 1919; for example, 1889, 1872, 1736, and 1680 (fig. 11). (Some of these fires likely burned a much larger portion of the CNF than just Cook Mountain, and the year 1889 also is known to have been a ubiquitous fire year throughout the Northern Rockies).

Table 1.--Major fires (>10,000 acres) occurring in the Cook Mountain study area, 1535-1928[1]

Approximate year	Estimated size (acres)	
(1535±)	(7,000+)	
1680	20,000+	
1736	44,000+	
(1772)	(7,000+)	
(1784)	(6,000+)	
1842	16,000+	
1862±3	10,000+	
1872	23,000+	
1889	70,000+	
1910	58,000+	[∿589,000 CNF]
1919	72,000+	[∿302,000 CNF]
1928	11,000+	[∿ 20,000 CNF]

MFI (1680-1928)[2]: 24.8-31.0

[1]Appendix A lists all large-fire years, and estimated sizes, from 1535 to 1928 in the study area.

[2]The unusually long 145-year period from 1535 to 1680 reflects the diminishing data base with time, therefore MFI's are calculated from 1680 to 1928.

Fig. 11 -- Major fires which occurred in the study area during the past three centuries. (Appendix B presents maps showing Cook Mountain fire history from 1535-1928.)

Burn maps: 1680, 1736, 1872, 1889, 1910, 1919

Key:

• : fire scar sample or snag cambium year.

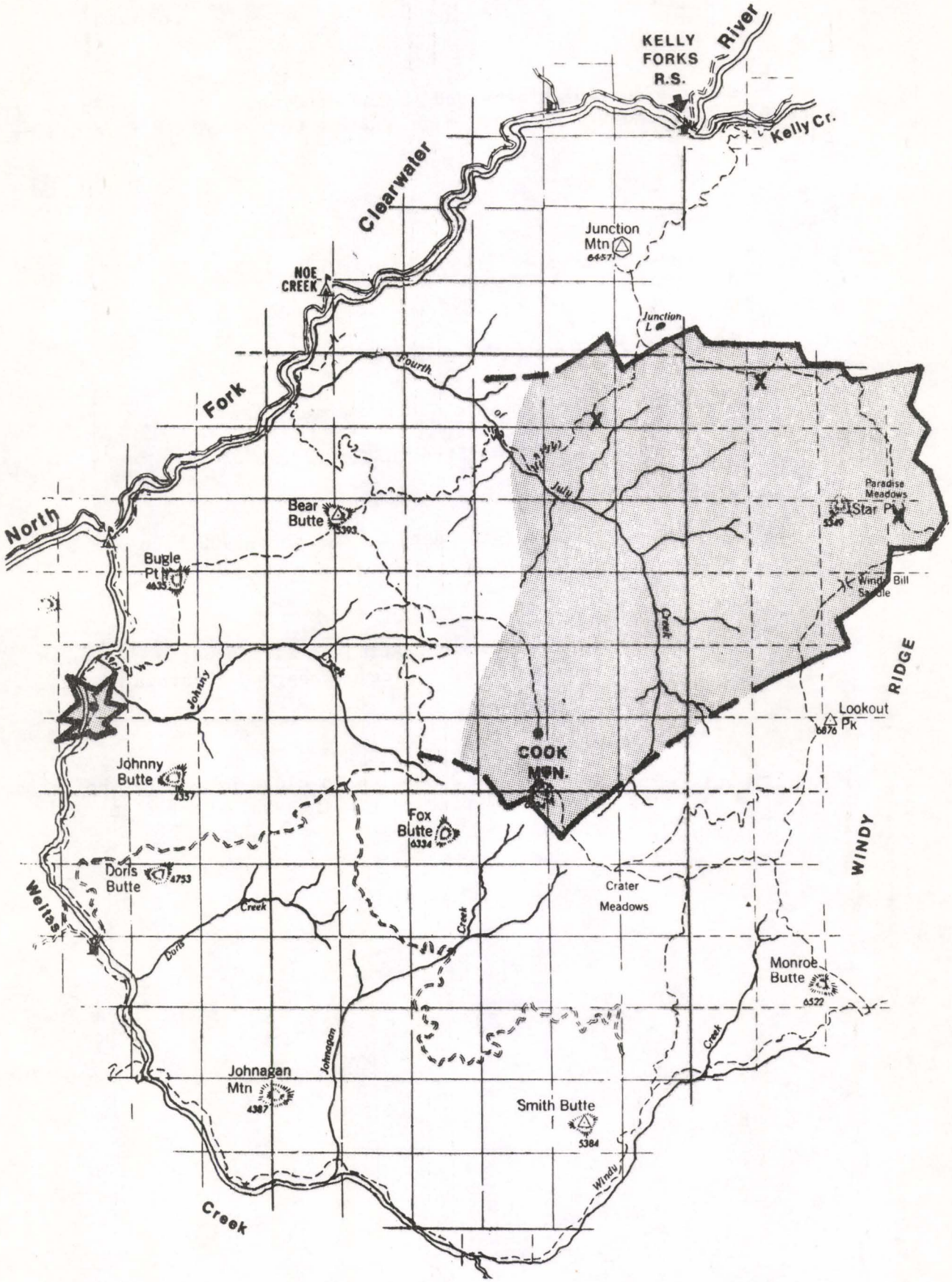
X : pith sample from fire-initiated age class.

: known fire margin based on CNF post-1900 burn maps.

: fire margin unknown; estimated margin based on sample locations and most logical topographic pathway.

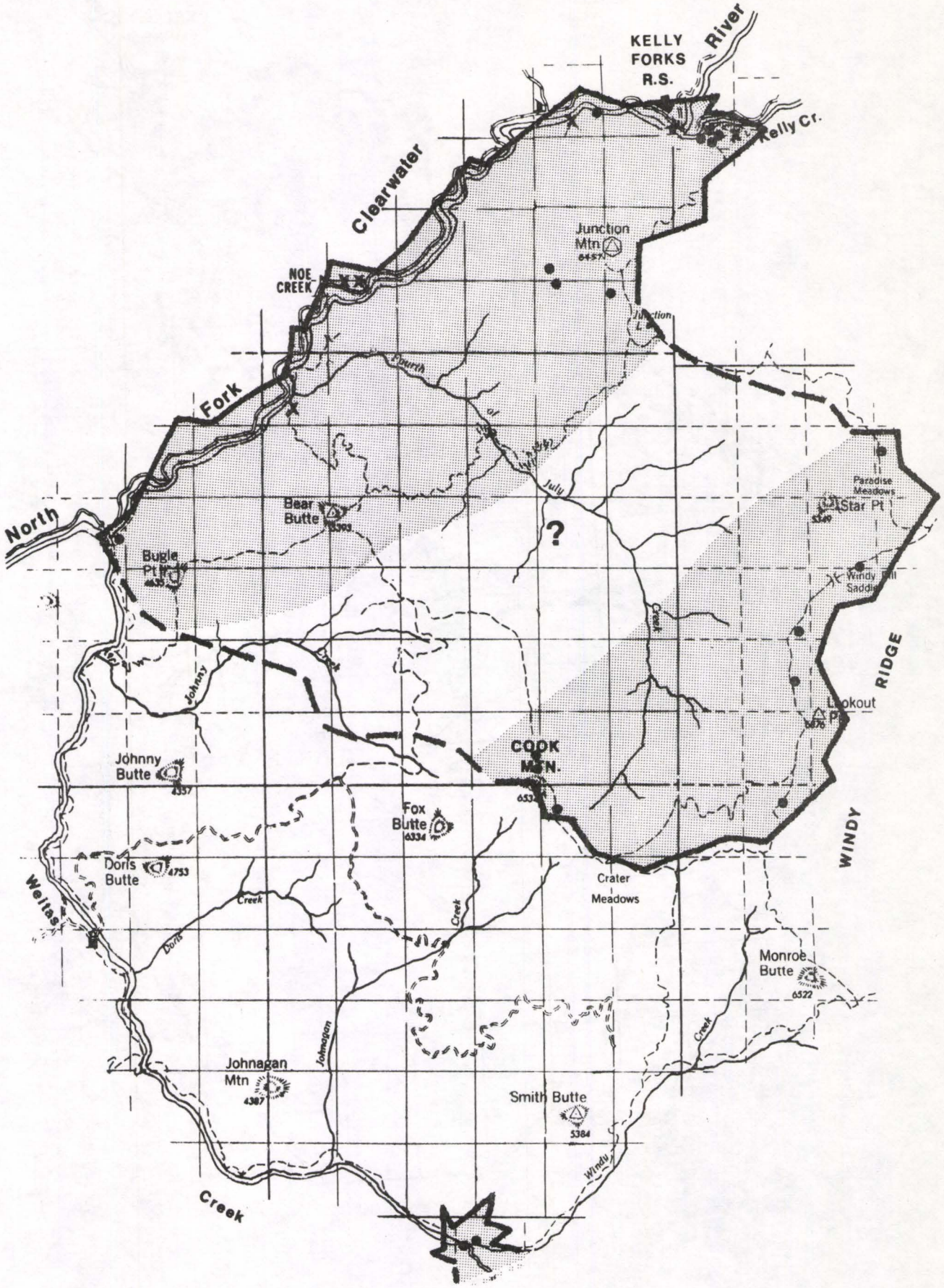
: single sample or 2 samples in close proximity, not allowing estimate of fire margin (possible spot fire).

1680*



* Estimated burn margins based on locations of snag age class.

1736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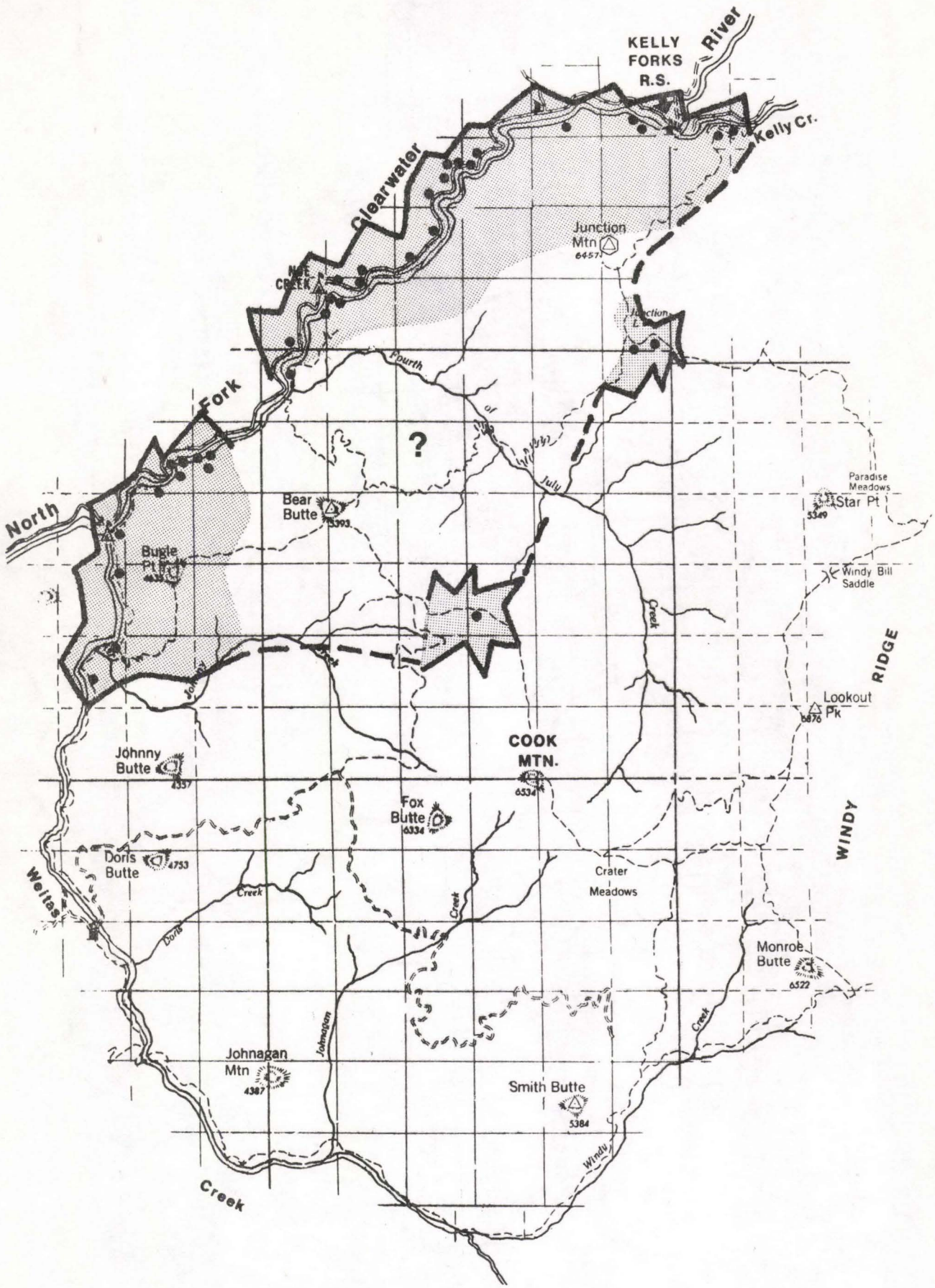
River
Kelly Cr.
Clearwater
Junction Mtn
NOE CREEK
North
Fork
Bear Butte
Bugle Pt
?
Paradise Meadows
Star Pt
Windy Saddle
RIDGE
Lookout Pt
COOK MTN.
Johnny Butte
Fox Butte
6334
Doris Butte
4753
Crater Meadows
WINDY
Monroe Butte
6522
Johnagan Mtn
4387
Smith Butte
5384
Creek

1872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Kelly Cr.
Clearwater
Junction Mtn
6457
Fourth
July
Fork
North
?
Bear Butte
5393
Bugle Pt
Paradise Meadows
Star Pt
5349
Windy Bill Saddle
RIDGE
Lookout Pk
6876
COOK MTN.
6534
Johnny Butte
6357
Fox Butte
6334
Doris Butte
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Crater Meadows
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Monroe Butte
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Johnagan Mtn
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Smith Butte
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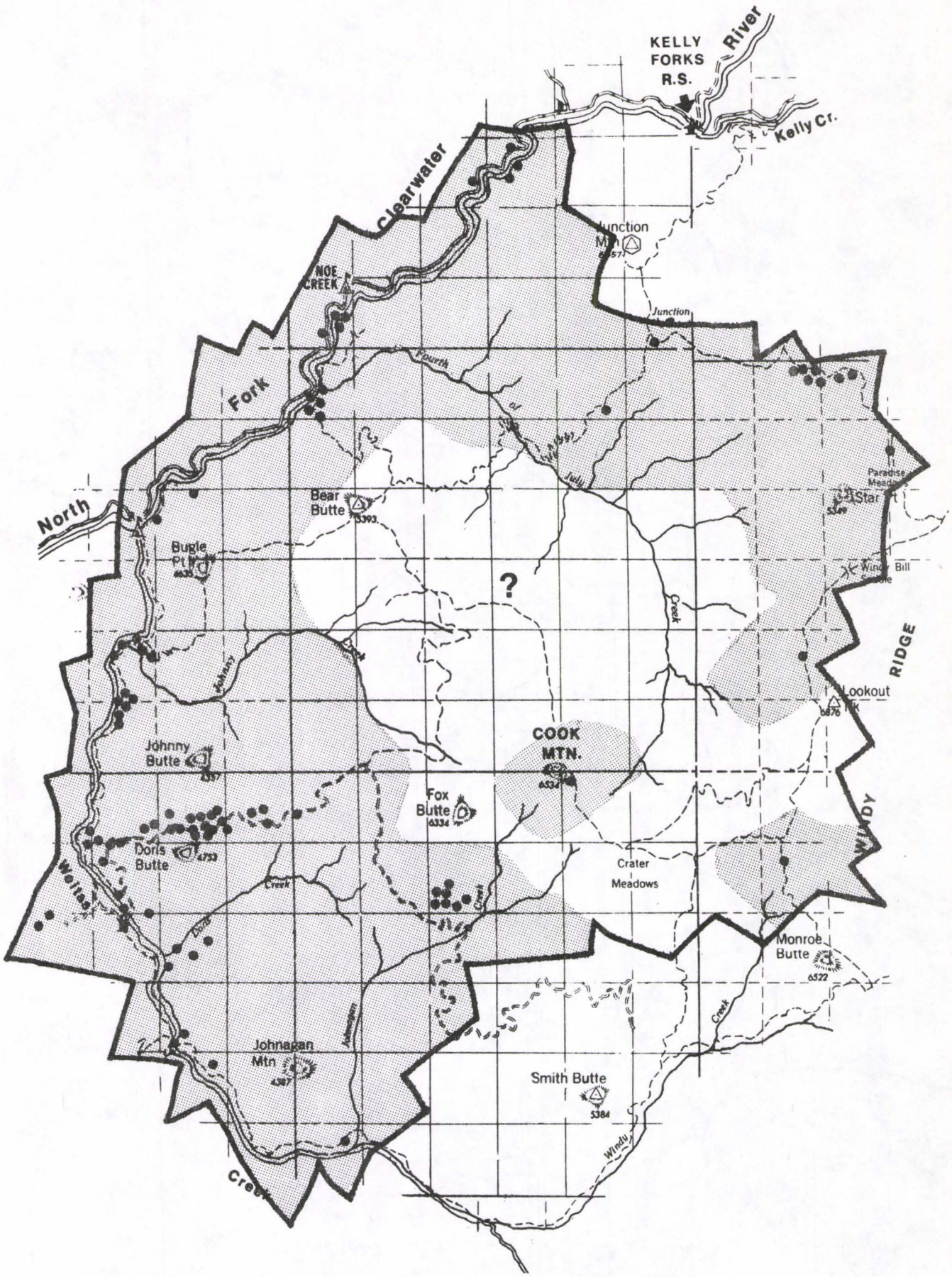
Creek

1889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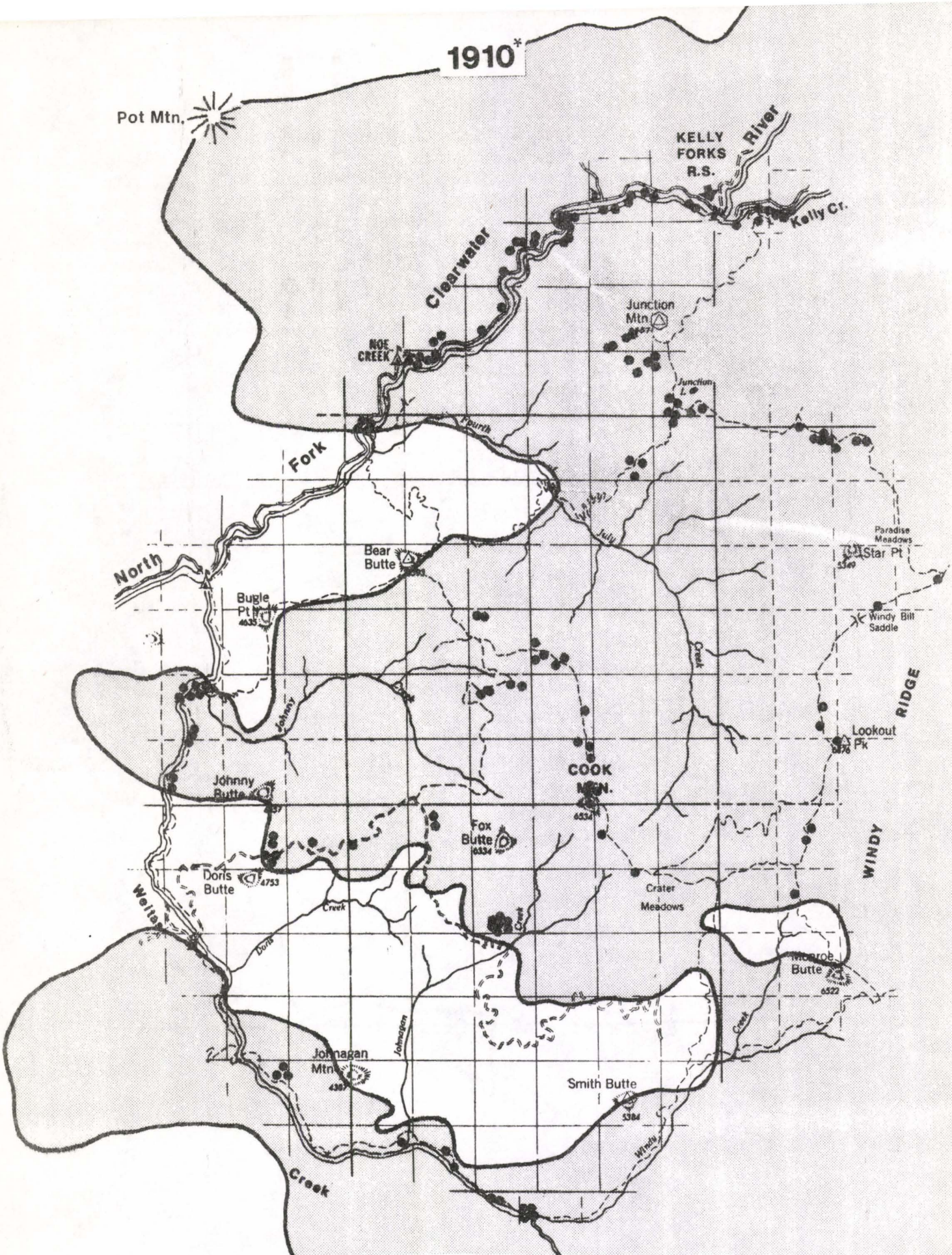
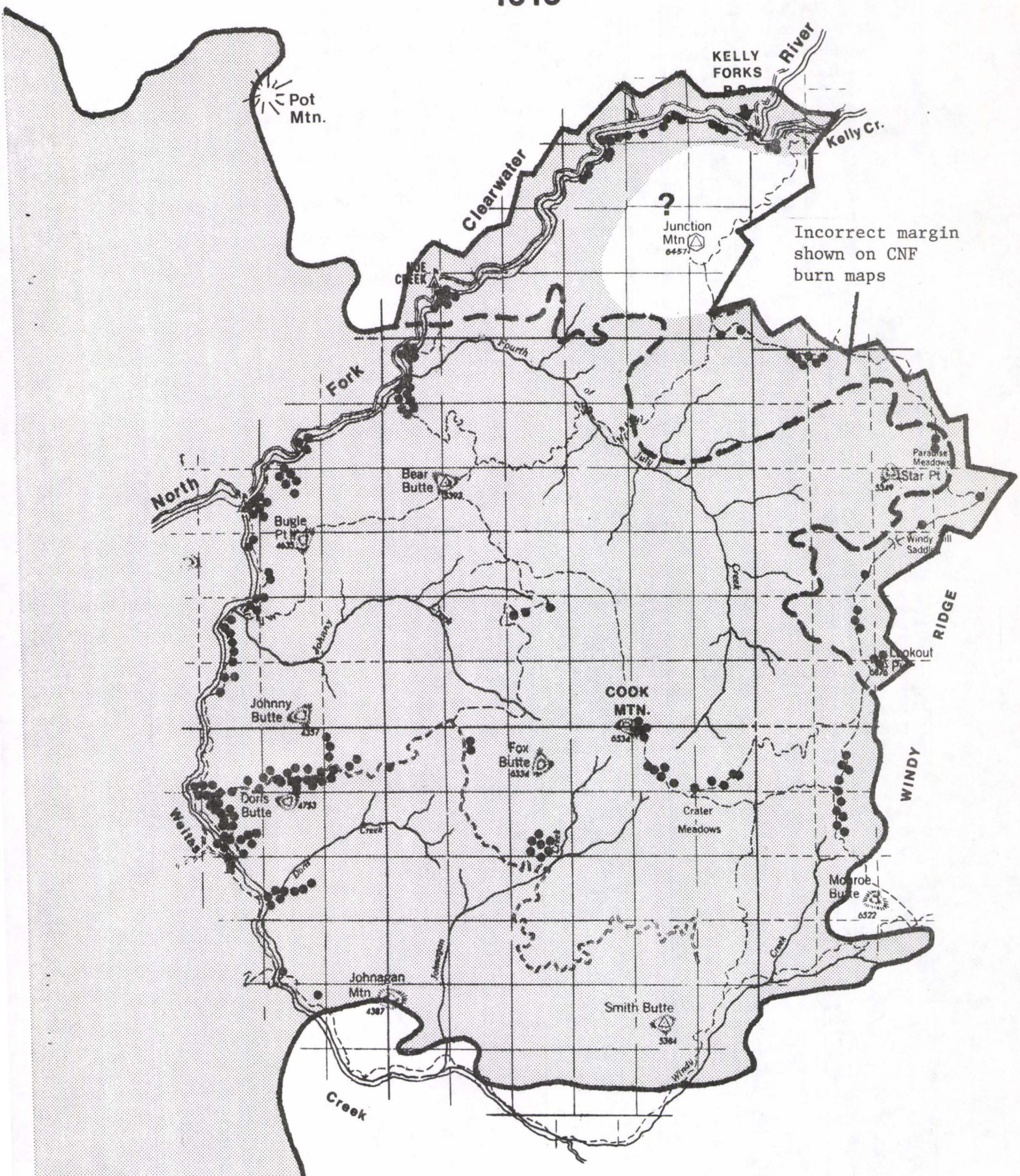
Johnagan Mtn
Smith Butte
Windy
Creek



* Burned area, CNF: ~589,000 acres

1919*



* Burned area, CNF: ~302,000 acres

Examination of MFI's for 28 small stands in the cedar, grand fir, and subalpine zones reveals a similar pattern of unexpectedly frequent fire (stand size generally is less than 100 acres). The range of MFI's for 11 cedar/pachistima stands was 24 to 77 years (11 stand mean: 47.8 ± 20), remarkable since 9 of these stands represent riparian communities (table 2). Individual fire intervals usually were from 30 to 100 years long. These 11 stands apparently burned substantially more often than has been estimated for cedar forests in the somewhat more mesic northernmost areas of Idaho, where MFI's of 50-200+ years have been calculated (Marshall 1928, Arno and Davis 1980) and where reburns apparently have been much less common.

Table 2.--Fire occurrence for 11 stands--
western redcedar/pachistima habitat types

Stand	Elevation	Aspect	Fire chronology	No. of fires	MFI	Fire interval range (years)
Kelly Forks Campground	2800-3000	N	1613-1919	5	76.5	9-174
Doris Creek	2800	W	1769-1919	3	75.0	30-120
Fawn Creek	2400	N	1700-1919	4	73.0	30-142
Fourth of July Packbridge	2400-2800	N	1736-1919	4	61.0	5-153
Slick Creek	4000	N	1772-1919	4	49.0	30-70
Davis Creek	4800	N	1795-1919	4	41.3	9-61
Windy Packbridge	3300	NW	1736-1928	6	38.4	18-69
Weitas Campground	2400	NW	1736-1919	6	36.6	6-106
High Creek	2800	NW	1736-1919	8	26.1	9-100
Cub Creek	2600-2800	N	1819-1919	5	25.0	6-41
Johnny Packbridge	2600	W	1749-1919	8	24.3	7-47
	Range		Range		Range	Range
	2400-4800		1613-1928		24.3-76.5	5-174
					Mean	
					47.8 ± 20	

As expected, MFI's became shorter ascending from the canyon bottoms into the drier grand fir zone. The 7 stands located in this zone had MFI's ranging from 19 to 46 years (7 stand mean: 28.7 ± 11) (table 3). Individual fire intervals usually were from 20 to 50 years long.

Table 3.--Fire occurrence for 7 stands--grand fir/pachistima habitat types

Stand	Elevation	Aspect	Fire chronology	No. of fires	MFI	Fire interval range (years)
Canyon Creek[1]	5000-5100	S	1680-1910	6	46.0	21-78
Cook Road #1	3800	W	1834-1919	3	42.5	30-55
Slick Ridge South	3200-3400	W	1842-1919	4	25.7	14-33
Cook Road #3	4300	N	1772-1919	7	24.5	9-47
Cook Road #2	3300	SW	1808-1919	6	22.2	14-30
Junction Packtrail[2]	3000-3600	N	1848-1910	4	20.7	15-30
Doris Ridge	3000-3800	N	1842-1919	5	19.3	14-33
	Range		Range		Range	Range
	3000-5100		1680-1919		19.3-46.0	9-78
					Mean	
					28.7 ± 11	

[1]Ecotonal to subalpine fir/menziesia h.t.

[2]Ecotonal to cedar/pachistima h.t.

Perhaps more remarkable than the findings for canyon bottom cedar forests are those for the subalpine zone, in which MFI's barely differed from those of the middle elevations. Ten stands had an MFI range of from 20 to 48 years (10 stand mean: 35.3 ± 10) (table 4). Individual fire intervals usually ranged from 40 to 70 years, excepting the short intervals caused by post-1889 reburns. These findings contrast sharply with the fire frequencies reported for subalpine forests elsewhere in the Northern Rockies (Arno 1980), where MFI's of 100-200+ years are common.

Table 4.--Fire occurrence for 10 stands--subalpine habitat types[1]

Stand	Elevation	Aspect	Fire chronology	No. of fires	MFI	Fire interval range (years)
Cook Mtn. North	6500	NW	1680-1919	6	47.8	9-98
Lookout Peak	6800	W	1786-1919	4	44.3	9-94
Crater Meadows North	6100	SW	1698-1919	6	44.2	9-117
Junction Lookout West	6100	SW	1736-1910	5	43.5	14-80
Lookout Peak South	6000	SW	1766-1919	5	38.3	9-56
Paradise Meadows	5500	SW	1740-1919	6	35.8	13-57
Crater Meadows East	6300	SW	1799-1919	5	30.0	9-68
Monroe Butte North	6000	S	1794-1919	6	25.0	9-39
Junction Lake Point	6200	SW	1796-1919	6	24.6	9-52
Cook Mtn. South	6500	S	1799-1919	7	20.0	9-57
	Range		Range		Range	Range
	5500-6800		1680-1919		20.0-47.8	9-117
					Mean	
					35.3 ± 10	

[1]Includes Abies lasiocarpa and Tsuga mertensiana habitat types.

Interpretations

The Cook Mountain area clearly represents the most profoundly fire-influenced ecosystems found in the Northern Rocky Mountains. These data tend to support and extend back in time the contentions of early investigators such as Leiberg (1899), Larsen (1929), and Gisborne (1932), which said of northern Idaho "Perhaps no other region in the United States is visited by forest conflagrations of similar magnitude, frequency or degree of destruction" (Larsen 1929: 67). In describing Idaho north of the Clearwater River (unfortunately excluding the North Fork Basin), Leiberg (1899) estimated that fires had destroyed fully 51 percent of the timber volume on 4 million acres from just 1860 through 1898.

While the Cook Mountain fire history can be characterized as severe, not all fires were catastrophic nor were all portions of one large fire. Field observations and the data indicate that the patterns of fire behavior on Cook Mountain were complex. Below is an interpretation of these patterns by habitat type.

RIPARIAN ZONE/UPLAND REDCEDAR HABITAT TYPES

Fires in these forests ranged from low to high intensity, often within the margins of a single burn, leaving a pattern of (1) light to moderate intensity underburns (leaving substantial numbers of surviving scarred trees, and lethal mainly to the smaller d.b.h. trees); (2) high intensity underburns with substantial crown scorch (few scarred, fire-resistant survivors, many with partially killed crowns); and (3) total stand replacement (running crown fires and severe surface fires). Large fires crossed even wide river canyons such as the North Fork of the Clearwater with little hindrance (fire scars often were cut on both sides of this river, usually within feet of the water's edge.) The relatively few snags over 20 inches d.b.h. in these potentially large-growth cedar forests attest to the long history of recurring conflagrations. However, the surprisingly short MFI's suggest that some of these fires likely originated in other, drier habitat types such as the grand fir series. The relatively infrequent lightning ignitions in the low-elevation, moist forests (Barrows and others 1977) probably often failed to set more than an inconsequential creeping duff fire.

Reburn potential apparently is serious after an initial stand-destroying fire (Wellner 1970). Downed, partially consumed fine fuels, numerous fire-killed heavy fuels, and elimination of the mature canopy's humidifying effect on duff and regenerating "flashy" fuels (Arno and Davis 1980) all create potential for a second, more intense, fire. (Silviculturally, this inherent reburn hazard can be inadvertently simulated by allowing large fuel residues to remain in cedar-zone clearcuts.)

MID-ELEVATION ZONE: GRAND FIR HABITAT TYPES

This zone includes moist habitat types (Abies grandis/Pachistima or /Menziesia) on sheltered north slopes, to small areas of very dry types (Pseudotsuga menziesii/Physocarpus malvaceus) on southwest or south-facing slopes. In general, fires often were large, and moderate to high intensity with a pattern of (1) severe surface fires and severe crown scorch (only a few surviving large-growth, fire-resistant trees per acre), and (2) running crown fires which destroyed entire stands (with individual runs of several hundred acres or more). In limited areas, especially on north slopes, evidence of low intensity underburns exists. However, fire-sensitive trees such as grand fir usually only were scarred once or twice a century at most (a few fire-resistant larch were able to sustain as many as four or five scars each).

Field examination of the large number of severely charred, reburned snags suggests that fires reached their peak intensities in these middle elevations, especially on west and south aspects. (Snags in the canyon bottoms and in the subalpine usually were in much better condition for sampling.) Larsen and Delaven (1922), Hayes (1941), and Arno and Davis (1980) also described "mid-slope thermal belts" in northern Idaho which are prone to high intensity burns, in part because of exposure to mid-summer warm, drying winds.

Reburn potential seems highest in these mid-slope forests, especially with the greater potential for lightning strikes in snags with the increased elevation. Drier aspects apparently reburned hottest although it seems likely that potential severity also could be quite high for mid-elevation, productive north slopes not totally destroyed by the previous fire.

SUBALPINE ZONE: SUBALPINE FIR/MOUNTAIN HEMLOCK HABITAT TYPES

When ignited at high elevations, fires probably most often were limited in size and were of low to moderate intensity. This situation would have been dictated by the relatively small accumulations of patchy, low-growing fuels such as beargrass and small shrubs. (Many subalpine trees such as fire-sensitive subalpine fir and mountain hemlock often were able to survive two or three fires, the scars bearing testimony to these lower intensities.) Therefore, like subalpine forests elsewhere in the region, significant fires of subalpine origin probably only spread through stands one to two times in a century. However, the many contiguous snags, consistently small d.b.h.'s, and the uncharacteristically short MFI's, all provide evidence that high intensity crown fires have swept up from lower elevations, carrying mainly through lodgepole pine canopies. Further evidence of high intensity subalpine fires is that, in 10 weeks of field reconnaissance, only a few small islands of old growth were discovered in the study area.

Reburns probably were not as frequent or intense in this zone, largely because of the inherently low productivity and increased spatial distribution of horizontal and vertical fuels. Fire scar data indicate that individual fire intervals of 50-100 years were common, and that the relatively short MFI's were caused largely by the major reburns within the past 100 years (e.g., 1889, 1910, 1919); longer fire intervals seemed to occur before about 1889 although intervals still were quite variable.

Reburn History

The fire scar data showed that there was a long-term pattern of reburns occurring throughout the 248 years from 1680 to 1928. There were no long reburn-free periods in the study area during this time; the 56 years from 1680 to 1736 and the 58 years from 1785 to 1842 were the longest spans. More multiple reburns seemed to occur, and with increasingly shorter intervals, from 1842 to 1928, but this pattern simply may be a result of the increasing data base toward the present. Still, it is generally recognized that the Northern Rockies' most severe drought in the past several centuries occurred from about 1916 to 1940 (Wellner 1970, Leaphart and Stage 1971), coinciding with some of the CNF's worst fire years in the early part of this century.

The essentially regular occurrence of reburns on Cook Mountain over the past 300 years suggests that factors other than severe drought periods may have been operating. The opening up (either by conflagration or by logging) of large tracts of relatively contiguous downed fuels probably can create and maintain severe wildfire hazards (Larsen 1924, Gisborne 1932).

Reburns may not always have been high intensity fires, however (pers. comm. with R. Space, CNF, retired). Unless extreme conditions of drought and wind prevailed, fires re-ignited in a mostly destroyed stand within perhaps the first two decades often may not have been able to carry well enough to reach high intensities (Stickney 1982[1]). This situation would be governed by (1) the relatively small amount of living fine fuels (mainly limited to resprouted shrubs and grasses), and (2) lack of intermediate-sized fuels necessary to carry a fire to sufficient intensity for ignition of the larger diameter, primarily standing, snags. An exception might be adjacent intense forest fires which carried into these previously burned areas, generating enough radiant heat to ignite even large diameter fuels.

It seems feasible that reburn intensity in these forests would be greater during the second or third decade after the initial burn because of (1) the increased diameter distribution of living fuels and increased tons per acre (including possibly tree regeneration), and (2) a better spatial distribution of horizontal and vertical fuels (more downed decaying snags; increased fuel ladders from floor to shrub/tree crowns and standing snags).

After four or five decades, reburn potential probably diminishes substantially, especially on sites with a mostly contiguous tree canopy (pers. comm. with C. Wellner, INT Moscow, retired). Fuel decay, the falling of large numbers of snags prone to lightning ignitions, and the effect canopy shade in cooling and humidifying fine fuels all combine to reduce fire potential.

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[1]Stickney, P. F. 1982. First decade of plant succession following a holocaustic forest fire, northern Idaho. Ecol. Monog. (Review draft).

The results of this investigation revealed strikingly more frequent fire occurrence than has previously been reported for northern Idaho's mesic forests (Marshall 1928, Arno and Davis 1980). Early man-caused fires may have supplemented the fire regime in the Cook Mountain area but lightning is expected to have been the primary ignition agent in the upper Clearwater Basin. A historic Nez Perce Indian trail is known to have crossed the subalpine ridges over Cook Mountain from the Lochsa River Basin. However, while Indians may have set some forest fires, the high lightning frequency in these heavily fueled forests probably made supplementation unnecessary and hazardous. (Former Forest Supervisor Ralph Space also was told by an old Nez Perce that burning was not practiced in the early days.) Leiberg (1899), neglecting the historical role of lightning, reported that prospectors destroyed many acres of timber in the late 1800's by carelessly or mischieviously caused fires. However, Cook Mountain's high fire frequency even before the advent of Europeans probably indicates that lightning has been the major causal agent.

It is not known why this region of northern Idaho is so prone to recurring conflagrations. However, a combination of at least three factors seems to make it vulnerable to severe fires: (1) much of the Basin represents the dry portion of northern Idaho's cedar/hemlock association (Daubenmire and Daubenmire 1968); less summer rainfall probably occurs here than in the forests of the Idaho Panhandle yet the Basin's forests are still luxuriant, providing ample fuels for large fires; (2) the southwest- or west-orientation of major portions of large river canyons (North Fork of the Clearwater River, Lochsa River) enhance the development of conflagrations because the canyons face the prevailing summer winds. (On a smaller scale Cook Mountain has 10 principal stream drainages which rise into the study area from the south, southwest, or west); (3) Larsen and Delaven (1922) suggested that many ridges in the Basin parallel these warm, dry summer winds and that a strong drying influence is exerted upon mid and upper slope forests; they felt that this, coupled with high regional lightning frequency, gave the area a very high fire risk. Thus for the CNF, perhaps more than other R-1 forests, these factors stress the importance of rapid fire suppression during summers, intensive silviculture (relatively short rotations, precommercial thinning, prompt logging slash treatment), and judicious prescribed burning.

MANAGEMENT IMPLICATIONS

Silviculture

REGENERATION ON REBURNED SITES

One objective of the study was to examine the reburn history of the Cook Mountain area to help identify tree regeneration potential on various sites. From a planning standpoint, identification of severely reburned sites was important for delineating the CNF's future investment priorities and management goals for Cook Mountain.

For the purposes of this analysis a "reburn" was defined as: the recurrence of fire over an area at a time when many of the fuels burned by a previous fire are available to burn a second time, and when tree regeneration is in the seedling/sapling stages. For the three forest zones in this study area, reburns probably can be considered to occur within 30 years of one another.

Large expanses of the study area were found to have severe reburn histories (table 5) (fig. 12). For example, much of the west-facing Doris Creek drainage burned twice in 1772-1784, and as many as five times from 1842 to 1919 (fig. 13). In the west-facing Weitas Creek/Bugle Point area, today largely nonstocked shrubfields above the riparian zone, as many as six fires occurred during the same latter period. It should be noted, however, that in many cases past fire occurrence can be discussed only for broad, imprecise areas because of the severe long-term destruction of evidence by fires.

Most of the Fourth of July drainage, a natural pathway for channeling large fires up into the study area's interior, has been very severely incinerated with essentially all fire scar evidence destroyed (very few snag remnants remain today). The hot southwest-facing slopes in this canyon now have very thin eroded soils, discouraging even shrub production.

Sixty-two 375-m^2 plots were located along the fire scar sample transects, on representative reburned sites within each habitat type. Since the goal was to examine tree regeneration, plots were located only in areas having substantial numbers of trees (essentially bypassing shrubfields having fewer than 100 trees per acre). The field data then were analyzed by habitat type, species, d.b.h. class, canopy coverage, aspect, elevation, and MFI. Stand table graphs were used to display canopy coverage by aspect and habitat type. Since the 1919 fire swept virtually the entire study area, plot regeneration represents that of Succession Year 62 (SY 62). However, to get an idea of post-reburn regeneration within about 30 years after the 1919 fire, canopy coverage regressions were roughly estimated for trees in the current 4-12" d.b.h. class (today about 30-62 years old). The resultant coverage estimates for SY 30 thus allow a view of tree regeneration existing on the plots in about 1950, or the then 0-4" d.b.h. class.

Table 5.--Locations and frequencies of reburns in the Cook Mountain study area

Location	Reburn chronology	Major habitat types	Elevation	Aspect	Years since last fire	Current regeneration status
			(feet)			
Doris Creek drainage	1772-1784 and 1842-1875-1889-1904-1919	Thpl/Pamy Abgr/Pamy Abla/Pamy /Mefe /Xete	2600-6500	N-SW-S	62	- well stocked Thpl, Abgr, Laoc - nonstocked (shrubfield) - partially stocked Abla, Pico
Weitas Creek outlet/Bugle Point area	1842-1862-1872-1878-1889-1919	Thpl/Pamy Abgr/Pamy	2400-4600	N-NW	62	- partially stocked Thpl, Abgr to nonstocked (shrubfield)
Fourth of July Creek outlet/ Bear Butte area	1872-1889-1896-1910-1919	Thpl/Pamy Abgr/Pamy	2400-5000	N-NW	62	- well stocked Thpl, Abgr, Laoc to nonstocked (shrubfield)
Kelly Forks/ Cold Springs area	1862-1878-1889-1896-1910-1919	Thpl/Pamy Abgr/Pamy Abla/Pamy /Mefe /Xete	2600-6000	NW-NE	62	- well stocked Thpl, Abgr, Laoc to partially stocked Abla, Pico
Johnagan Mtn./ Smith Butte area	1889-1910-1919-1928	Thpl/Pamy Abgr/Pamy	3200-5000	S-SW	53	- nonstocked (shrubfield)

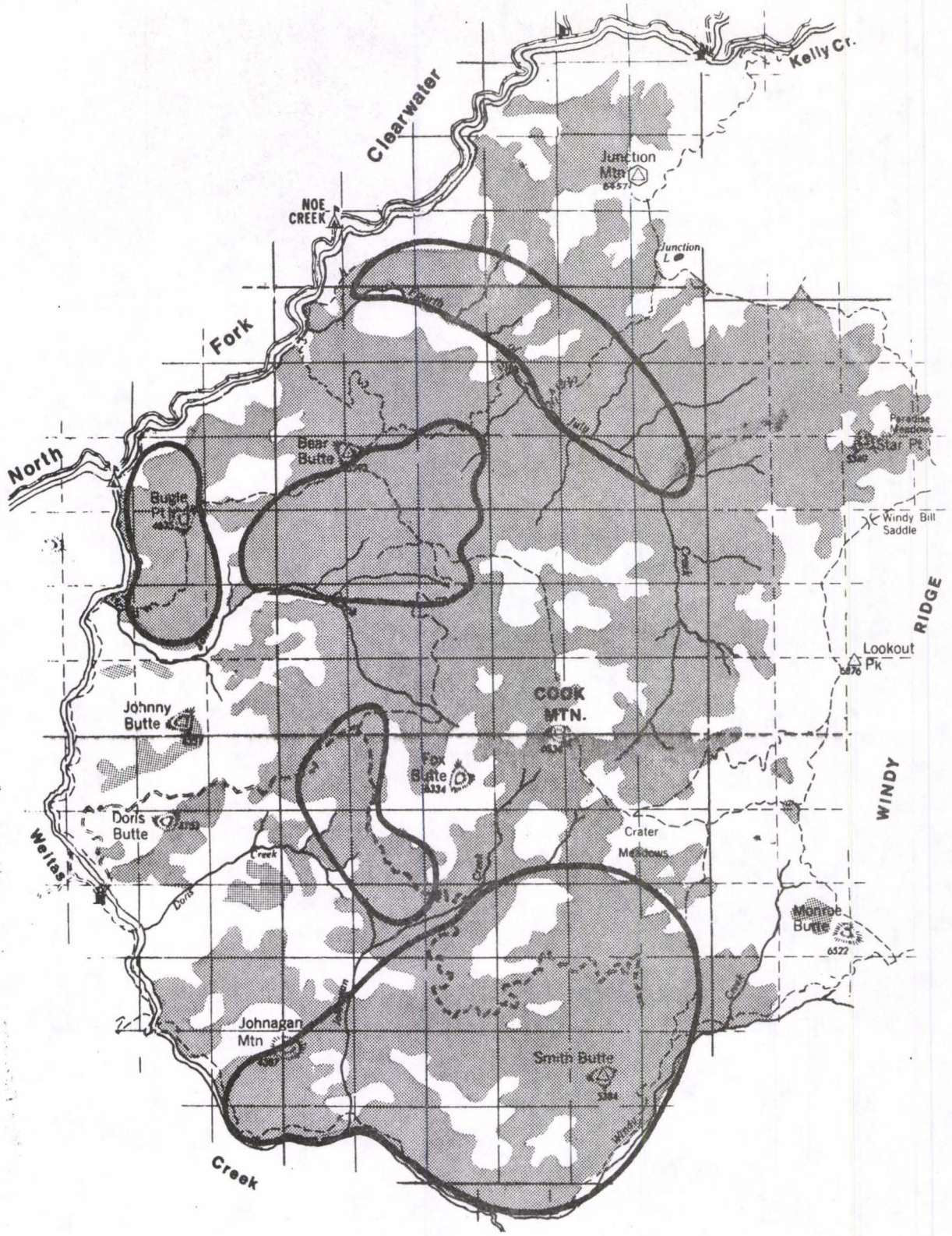


Fig. 12 -- Cook Mountain non-stocked areas (shaded). Circled areas represent reburned primarily south- or west-facing shrubfields which present the most serious problems for tree regeneration. Multiple plantings on a number of these sites have resulted in survival rates as low as 50:500 trees per acre (pers. comm. with E. Norby, CNF Forest Silviculturalist).

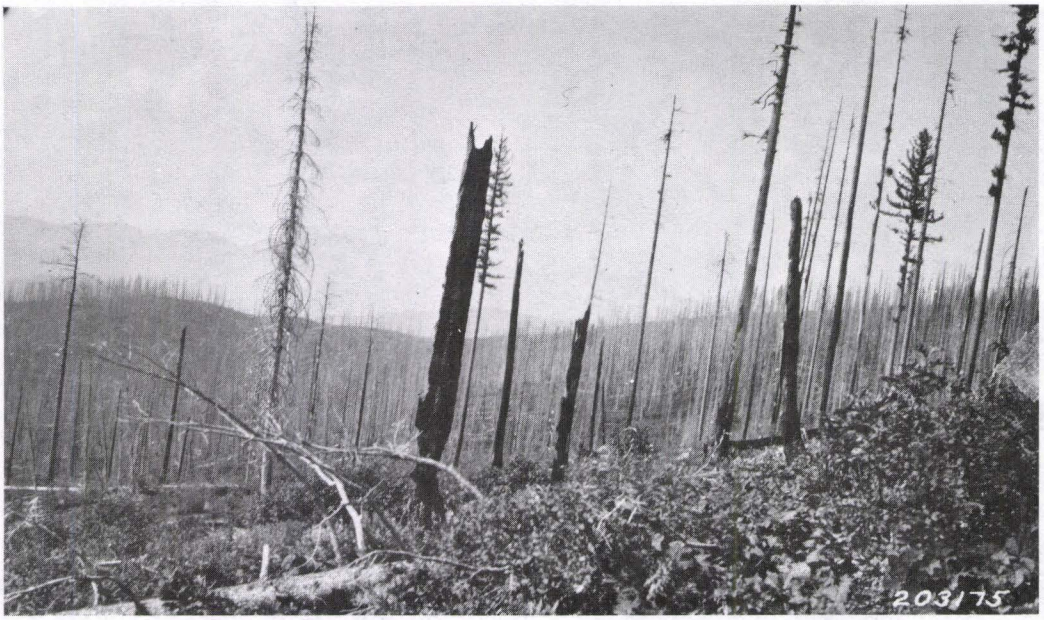


Fig. 13 -- Upper Doris Creek Basin 6 years after the 1889-1904-1919 reburn sequence (October 1925). Lack of large-d.b.h. snags is indicative of Cook Mountain's long history of severe fires and scarcity of residual seed trees illustrates the opportunity for widespread shrub dominance.

All of the 62 plots apparently burned from two to five times in the 50 years from 1869 to 1919. No specific pattern of regeneration differences was noted between plots with different numbers of reburns; most appeared to have at least triple burned in the 50-year period. In fact, of the factors examined and cited above, only habitat type and aspect seemed to emerge as traceable factors in regeneration success after reburns. (Insufficient data were obtained for the east aspect because the study area and trails generally are oriented to the west, south, and north.) In terms of comparing relatively undisturbed stands with reburned stands, a 10-week reconnaissance of the study area produced only three plots which were known not to have reburned; these were all found in near-climax subalpine forest (small, undisturbed islands in the mountain hemlock/beargrass habitat type). Thus the severe burn history on Cook Mountain makes such comparisons infeasible. (Future investigations would need to look outside this study area to obtain old growth plots for the three habitat type series.)

The mean canopy coverages for the present 4- to 12-inch size class indicate that north slopes generally were well stocked 62 years after 1919, even after multiple reburns (fig. 14). This is especially true for the cedar and grand fir habitat types ($\bar{x}$ canopy coverages during SY 62 = 70 ± 31 percent and 60 ± 42 percent, respectively). However, the large variation about the means suggests that regeneration even on moist north slopes can be retarded by reburns; this probably is largely a function of extensive acres of seed source depletion (distance from seed sources) rather than any long-term site degradation. The regression estimates suggest that during SY 30 these same plots often had more than 50 percent canopy coverage (fig. 15), generally indicating good postfire regeneration.

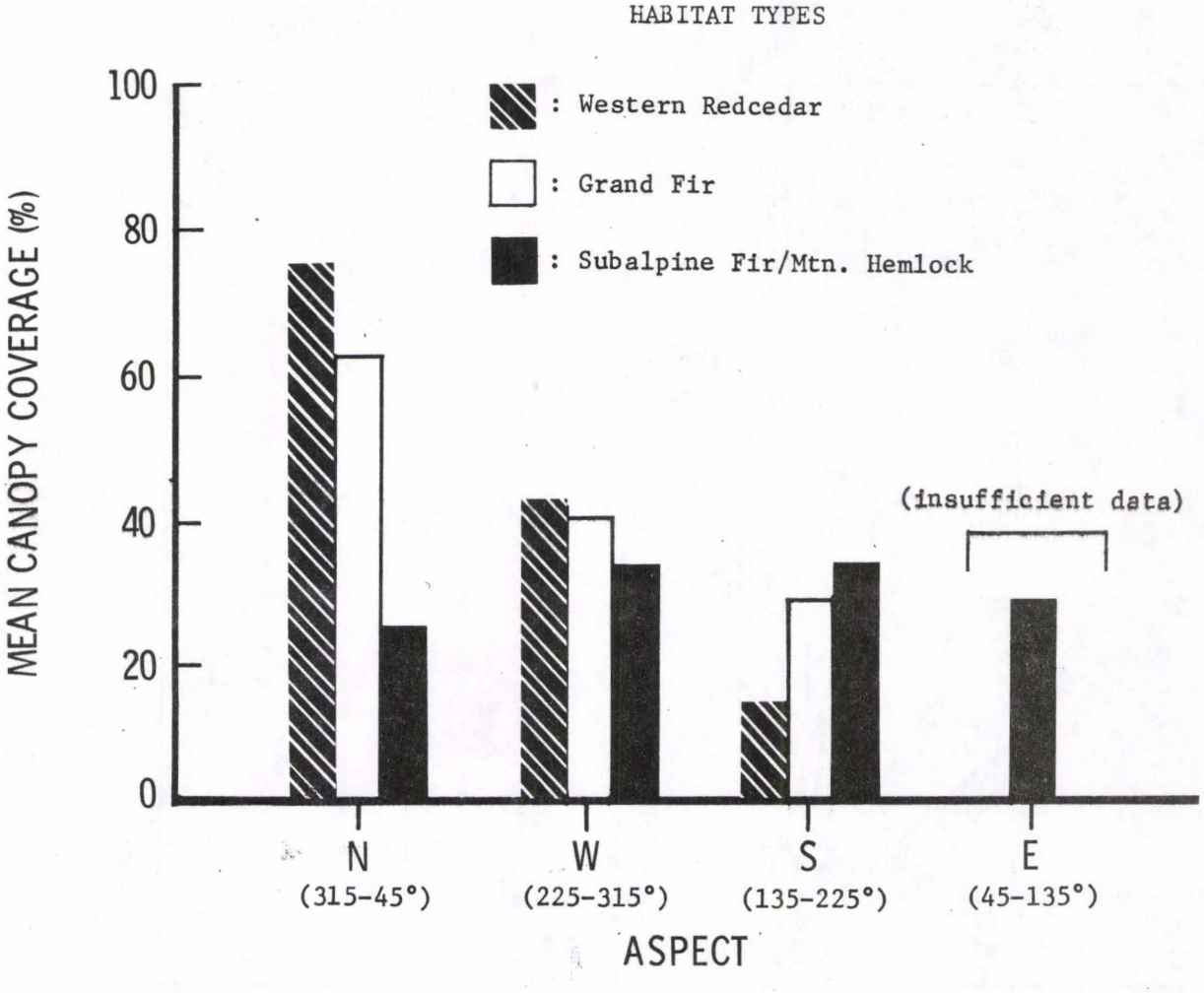
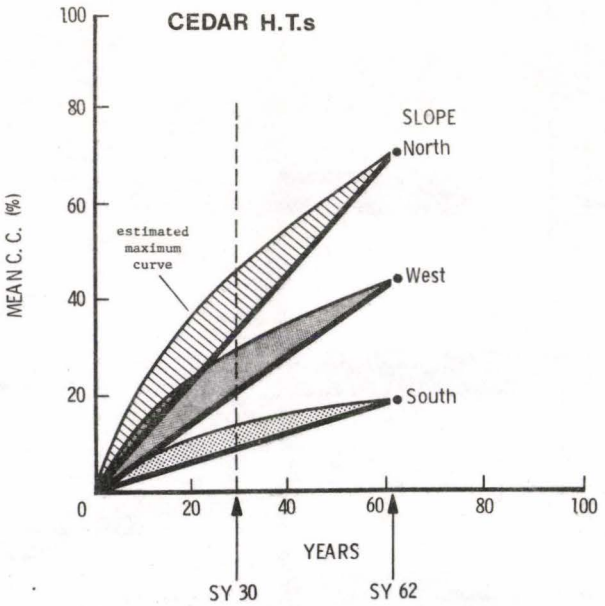
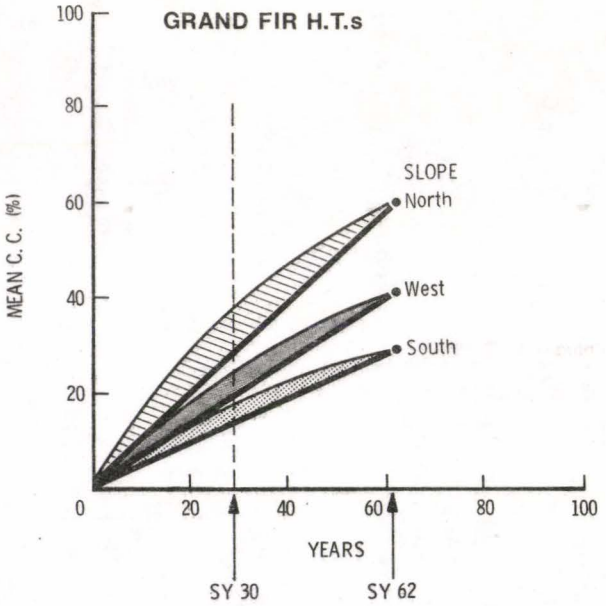


Fig. 14 -- Post-1919 mean canopy coverages (all species) during SY 62 for the 4-12" DBH class in 62 cedar, grand fir, and subalpine fir/mtn. hemlock habitat type plots, according to aspect. All plots burned 2-5 times from 1869-1919.





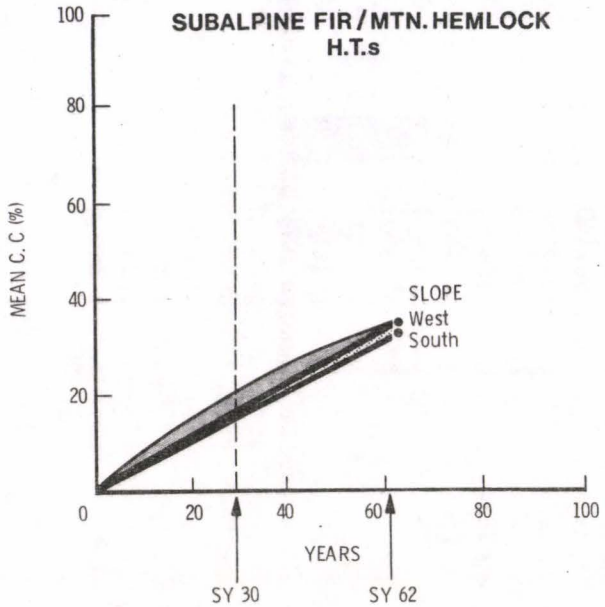


Fig. 15 -- Tree canopy coverages on 62 reburned habitat type plots during various succession years after the 1919 fire. Graphs show mean coverages by aspect during SY 62; estimated regression values also are shown for SY 30.

After north slope crown fires, larch and lodgepole pine were the most prolific invaders and often remain the dominant trees in even-aged canopies today. (White pine [Pinus monticola], although today not a significant seral component on Cook Mountain, apparently was a vigorous pioneer species in past low elevation stands elsewhere on the CNF [Leiberg 1899, Larsen 1929, Gisborne 1932]). At SY 62, suppressed understory shade-tolerants such as cedar, grand fir, or subalpine fir usually comprised the lower canopy in sizes and numbers sufficient for precommercial thinning.

Lower intensity burns on north slopes, while still apparently lethal to many overstory trees, often regenerated directly to climax species and varying amounts of shade-intolerants. This pattern of burning led to predominantly uneven-aged stands. Such a successional sequence presumably resulted because some overstory seed sources remained and mineral soil, necessary for widespread germination of shade-intolerants, was not totally exposed.

West slopes, especially in the cedar and grand fir types, have regenerated more slowly after reburns than north aspects (fig. 14). At SY 62 the mean canopy coverages were substantially less than those described above (cedar h.t.'s $\bar{x}$ = 43 ± 15 percent; grand fir h.t.'s $\bar{x}$ = 41 ± 24 percent; subalpine h.t.'s $\bar{x}$ = 36 ± 33 percent). Mean coverages also were less variable than those for north slopes, perhaps suggesting a more uniform and predictable response after reburns. The regression estimates suggest that during SY 30 these same plots in the cedar, grand fir, and subalpine series often had less than 25 percent canopy coverage (fig. 15), perhaps indicating marginal post-fire regeneration potential. Silviculturally, this suggests a more pronounced need for supplemental plantings, seeding, or allowance for substantial numbers of residual seed trees after harvests.

In the cedar and grand fir types the same species regeneration pattern described above is apparent on west slopes, except that lesser stocking is often characteristic. However, more grand fir and Douglas-fir were noted, suggesting that these species might be well adapted for planting survival on this drier aspect if a source of shade exists.

South slopes generally have been severely impacted by reburns (fig. 14), except in the subalpine habitat types, where regeneration response was highly variable. Canopy coverages on regenerating plots in the cedar/grand fir types usually were less than 30 percent even during SY 62 (note that because of time limitations sampling did not include the large acreages of virtually treeless, shrub-dominated sites found on Cook Mountain). The regression estimates suggest that during SY 30, canopy coverages often may have been less than 10 to 15 percent (fig. 15).

Species composition on south slope, low elevation plots is similar to that on west slopes, except with increasing numbers of Douglas-fir, grand fir, and fewer larch. With increasing elevation even-aged lodgepole pine stands or beargrass and graminoids usually are the predominant vegetation.

From field observations, the general lack of snag remnants over large expanses of south slope suggests a long-term history of shrubfield domination on Cook Mountain. Stands of bracken fern and graminoid communities also are locally extensive and these almost totally exclude tree regeneration because of intense competition from deep, mat-like root systems. Close inspection of the shrubfields, however, show scattered Douglas-fir and grand fir seedlings (<30 per acre) suggesting that after six decades some sites slowly are becoming receptive to shade tolerant trees. Dr. Leon Neuanschwander (University of Idaho, School of Forestry) felt that unless these shrubfields are continually recycled by fire or other disturbances, shrub dominance may begin to decline markedly by about SY 50-60. The Cook Mountain fire scar data indicate that such a cycle often would not have been allowed to complete itself, resulting in shrubfield perpetuation for at least the past 200 years on some sites (although fire scars were not often found in the shrubfields, fire occurrence is expected to have been similar to that of the adjacent forests); MFI's exceeded 60 years in only 4 of 28 forested stands selected for fire history analysis (riparian to subalpine zones) although individual fire intervals of more than 100 years have occurred in some. These factors, coupled with the increasing distances from seed sources with each successive reburn, have encouraged long-term shrubfield dominance over large areas of Cook Mountain.

Some sites on Cook Mountain may have little potential for coniferous tree establishment at this time. A long-term history of reburns might produce at least three effects precluding forest production: (1) continual shrubfield recycling, which over the long-term might elevate soil pH's beyond levels conducive to conifer establishment (CNF Soil Scientist Dale Wilson has identified mapping units within the study area in mid to upper elevations where soil mollification is occurring, indicating long-term dominance of deciduous vegetation, and he has classified these as "non-forest" sites); (2) reduction of soil wood component which serves as a medium for soil microbes important for nitrogen-fixation (Harvey and others [1976] indicated that long-term reduction of decaying wood on a site might be detrimental to formation of mycorrhizae, N-fixation, and other soil processes); (3) surface erosion and dry creep (debris avalanches) after fires, reducing the highly productive ashcap layers (CNF's Wilson has documented evidence of both processes on Cook Mountain and feels that this problem is limited mainly to the upper elevations; former CNF Forest Supervisor Ralph Space said that beginning in the spring after the 1919 burn, the North Fork of the Clearwater was heavily silted until mid-July; similarly, Hooker and Tisdale (1974) found evidence of a large amount of soil movement occurring on nonforested steep slopes above the Lochsa River). Such soil changes, precipitated by fire, might maintain a "fire/edaphic" or shrubfield climax on Cook Mountain's most severely burned and exposed sites. General observations elsewhere in the Clearwater Basin suggest that this successional pattern also may exist on other potential cedar/grand fir sites south of Cook Mountain; for example, in the lower Lochsa and Selway River canyons last burned by the 1934 "Pete King Fire" (234,000 acres). In light of this possibility, site-by-site fire history and soils analyses are recommended for such areas, prior to planning continued reforestation investments such as prescribed burning and planting.

Since most shrubfields in the study area currently are beyond SY 50, the best means of encouraging tree establishment on sites receptive to trees may be (1) continued wildfire exclusion, along with (2) site preparation methods which do not stimulate sprouting shrubs and graminoids, and (3) planting or seeding of hardy pioneer species such as larch, lodgepole pine, white pine, or Douglas-fir, perhaps under the partial shade of killed shrubs (especially on southerly aspects where evapotranspiration is highest).

The results of this inventory, the experience of the Cook Mountain Reforestation Project, and the literature all suggest that prescribed burning or other site-disturbance techniques are not appropriate for site preparation in shrubfields. On Cook Mountain, methods such as burning, scarification, plowing, terracing, and various combinations consistently stimulated the root crowns of sprouting shrubs and other long-established vegetation, giving them a competitive advantage over planted seedlings. South of Cook Mountain on south slopes above the Lochsa River, Hooker and Tisdale (1974) reported extremely rapid recovery of bracken fern (1/2 to 1-inch average growth per day within 3 weeks) and most shrubs following spring shrubfield burns of moderate to high intensity; light intensity burns tended to favor established graminoids. Improper herbicide application followed by burning also can perpetuate shrubfields because of (1) lack of shrub root crown or herbaceous mortality and subsequent sprouting, (2) in-seeding, and (3) germination of numerous onsite seeds (seeds of Ceanothus spp. can lie dormant and remain viable for centuries). Many currently available herbicides are species-specific and broadcast-spray methods often fail to contact protected understory plants in these multilayered communities (pers. comm. with R. Boyd, Moscow INT). Converse to the often practiced "brown and burn" techniques, INT Research Silviculturalist Raymond Boyd feels that the opposite may be more effective for site preparation; that is, summer burns followed by herbicide application to destroy sprouting and germinating vegetation in the previously protected lower layers. Planting after double application of herbicides (initial defoliation followed by a second application to eradicate sprouts, thus depleting root reserves) also may be an option, although ecologically questionable and expensive.

The past reburn responses in the Cook Mountain area suggest other implications for silviculture. For the forested north and west slopes, development of appropriate silvicultural prescriptions for the cedar/grand fir types often means imitating these ecosystems' historic responses to fire. For example, the plot data for north slopes indicate that larch is most successful after the most intense stand-replacing burns (imitated by even-aged management, perhaps using small clearcut or seed tree harvests and slash treatment); moderate to high intensity burns often favor lodgepole pine on drier aspects in upper elevations; later successional species such as grand fir and Douglas-fir often regenerate well on most aspects after burns of more moderate intensity which do not destroy the entire stand or expose large amounts of mineral soil (shelterwood, selection cut). Plot data for SY 62 and the knowledge that historic MFI's often were less than 50 years in lower elevation forests, suggest that precommercial thinning and slash treatment often could be used by the fifth decade to increase stand vigor and possibly reduce wildfire hazard.

However, while underburns did occur on Cook Mountain, the evidence suggests that prescribed underburning can be hazardous in densely stocked stands, especially on the steepest slopes. (Relatively few even fire-resistant trees were able to survive the high temperatures and crown scorching of past fires on mid-elevation, northerly aspects.) Underburning probably is most feasible on the less productive, drier south and west slopes, especially when occupied by fire-resistant trees such as mature larch or Douglas-fir (field observations indicate that underburns often killed mature, fire-sensitive grand firs or cedars directly by lethal heating of cambiums or indirectly by scarring, allowing pathogens or insects to gain access to inner wood). Finally, given the past frequency of catastrophic fires, wildfire hazard on the CNF might best be reduced by using short silvicultural rotations, a variety of different-aged cutting units of small size, and prompt slash treatment after harvests.

Soils Research

The CNF probably would benefit by an intensive investigation into possible long-term soil degradation on Cook Mountain and other similar areas. This could include examination of soil pH levels, soil microbe processes, and erosion potential under various fire regimes, followed by further development of the CNF's soil classification/mapping systems. Such an investigation might best be conducted concurrent with site-by-site fire history analysis (perhaps in the form of a Master's or Ph.D. thesis).

Fire Management

Since reforestation is the primary objective on Cook Mountain, continued wildfire exclusion seems appropriate for most sites for at least three reasons. First, in terms of wildfire hazard, the data indicate that while fires often occurred at average intervals of 25-50 years these MFI's probably would have been substantially longer were it not for recurring reburns. (Individual intervals in a given stand often were as long as 100 years.) Therefore even though most stands have surpassed SY 50, fire suppression probably has not markedly influenced stand structure and fuel conditions to the point of making the stands prone to high wildfire hazard.

Second, as previously described, prescribed burning alone probably is a poor site preparation technique in shrubfields where reforestation is the objective. Suppression of wildfires also should be given high priority in such areas.

Third, while prescribed underburning in standing timber can be a valuable tool for fuel reduction and understory thinning, the fire history evidence indicates that this technique can be hazardous in cedar/grand fir stands; this is especially true for productive north slopes and for young, low-canopied stands such as presently exist in the study area.

Wildlife Habitat

Wildlife species which depend on early successional vegetation apparently have been favored for centuries on much of Cook Mountain. For example, frequent fires continually recycled big game browse. However, with the general absence of fire for the past five or six decades, big game habitat is declining because most shrubfields apparently are too tall, and declining in productivity and nutritional value (Leege 1968, Hooker and Tisdale 1974). Forest cover/forage ratio, identified in the Cook Mountain Analysis Report as ideal at 50/50 percent, currently is as low as 30/70 percent because of the large areas of contiguous shrub domination (tall shrubs, some up to 30 ft high, can provide substantial cover, however). Therefore, in areas managed primarily for big game, prescribed fire now may be desirable for browse rejuvenation preferably on sites bordering forest cover.

Cook Mountain's substantial long-established rodent populations have been troublesome in the reforestation effort because of considerable seedling consumption. Frequent past fires have perpetuated their habitat by continually recycling bracken fern and graminoid communities. In areas where reduction of rodents is the goal, continued fire exclusion will again be appropriate for habitat reduction through long-term succession.

SUMMARY

Multiple reforestation failures since 1963 on Cook Mountain led the Clearwater National Forest (CNF) to investigate fire history in an attempt to (1) determine the past role of fire in the area's potentially productive cedar/grand fir/subalpine fir habitat types, and (2) to determine fires' impact on tree regeneration potential. The 83,000-acre study area, representing many areas of the CNF, was for at least the past 400 years found to have been subjected to the most severe fire treatment possible in forest ecosystems--that of frequent holocaustic fires followed by multiple reburns.

Post-1919 tree regeneration occurring on the area's forested sites (comprising only about 32 percent of the study area) was found to be marginal to poor on many aspects other than moist north slopes, where recovery generally is rapid. Many of the area's extensive south- and west-facing shrubfields have predominated perhaps for 200 years or longer. Some sites, reburned as often as five times in the 50 years from 1869 to 1919, actually may represent a "fire/edaphic" climax in which long-term soil degradation may be inhibiting forest establishment.

Determination of regeneration potential on a site-by-site basis is the suggested prerequisite to planning continued reforestation investments on Cook Mountain. Future efforts might focus on detailed soils investigations in conjunction with site-specific fire history analyses to help delineate the appropriate future course of investments for severely disturbed sites on this and other similar areas of the CNF.

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APPENDIX A

TWENTY-FIVE MAJOR FIRE YEARS WHICH OCCURRED IN THE COOK MOUNTAIN STUDY AREA FROM 1535 to 1928

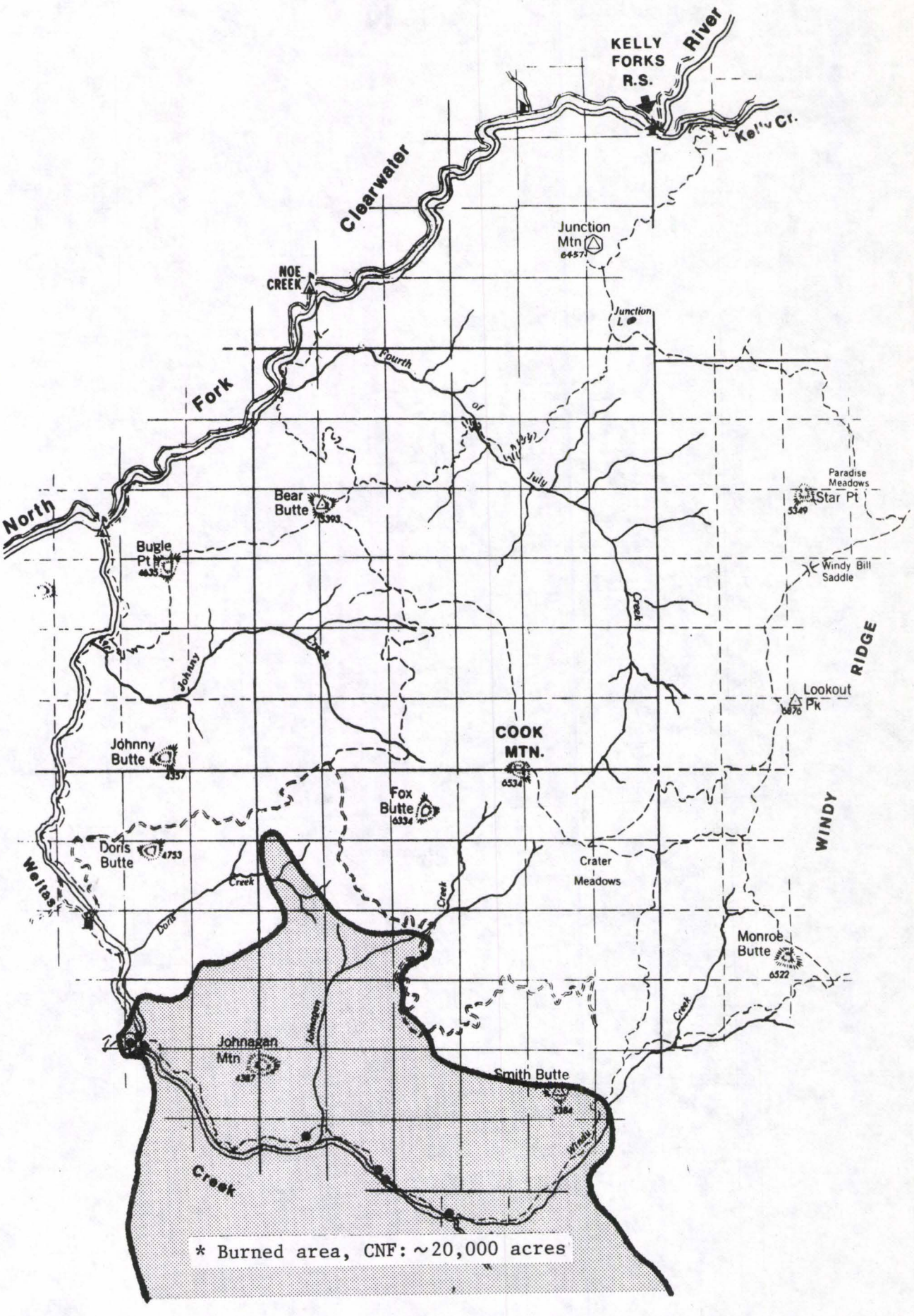
Approximate year	Estimated size	
1535±	7,000+	
1680	20,000+	
1736	44,000+	
1765±3	2,000+	(possibly more than one fire year)
1772	7,000+	
1784	6,000+	
1798±3	1,000+	(possibly more than one fire year)
1805	2,000+	
1820±6	1,000+	
1823	4,000+	
1828	1,000+	
1842	16,000+	
1852	2,000+	
1862±3	10,000+	
1872	23,000+	
1875	6,000+	
1878	3,000+	
1889	70,000+	
1896	6,000+	
1904	2,000+	
1906	2,000+	
1910	58,000+	
1914	2,000+	
1919	72,000+	
1928	11,000+	

APPENDIX B

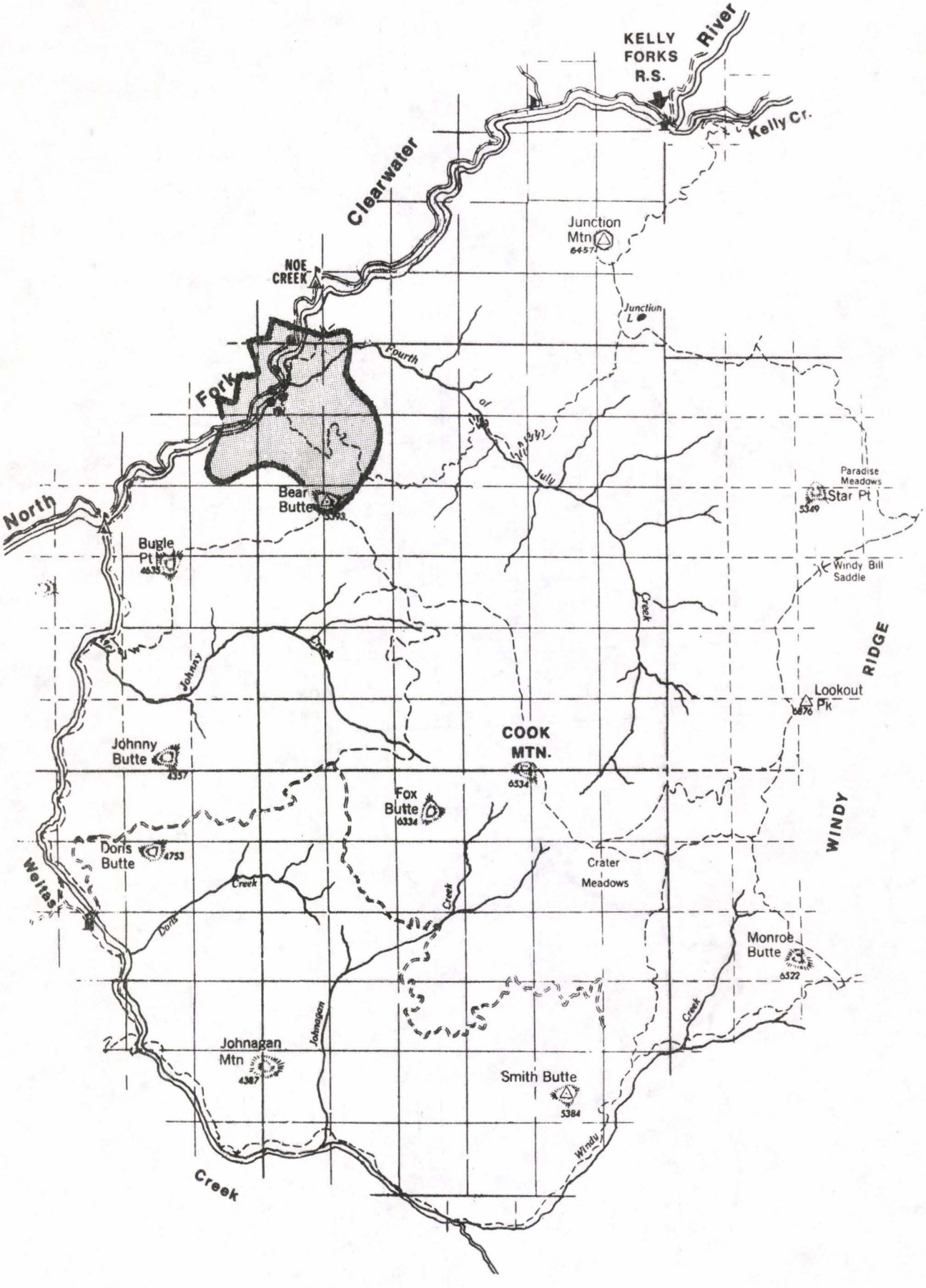
TWENTY-FIVE FIRE MAPS DISPLAYING COOK MOUNTAIN FIRE HISTORY, 1535-1928

(Fire maps for 1680, 1736, 1872, 1889, 1910, and 1919 appear on pp. 17-22)

1928


KELLY FORKS R.S.
River
Kelly Cr.
Clearwater
Junction Mtn
6457
NOE CREEK
Junction L.
Fourth
Fork
North
Bear Butte
5393
Bugle Pt
4435
Paradise Meadows
Star Pt
5349
Windy Bill Saddle
Creek
Johnny
Creek
RIDGE
Lookout Pk
6870
COOK MTN.
6534
Johnny Butte
5357
Fox Butte
6334
WINDY
Doris Butte
4753
Crater Meadows
Weitas
Creek
Creek
Doris
Monroe Butte
6522
Johnagan Mtn
4387
Johnagan
Smith Butte
5384
Creek
* Burned area, CNF: ~20,000 acres

1914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Fourth
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Bear Butte
Paradise Meadows
Star Pt
5349
Bugle Pt
4635
Windy Bill Saddle
Creek
Johnny
Creek
RIDGE
Lookout Pk
6876
COOK MTN.
6534
Johnny Butte
4357
Fox Butte
6334
WINDY
Doris Butte
4753
Crater Meadows
Weitas
Creek
Doris
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Monroe Butte
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Johnagan
Johnagan Mtn
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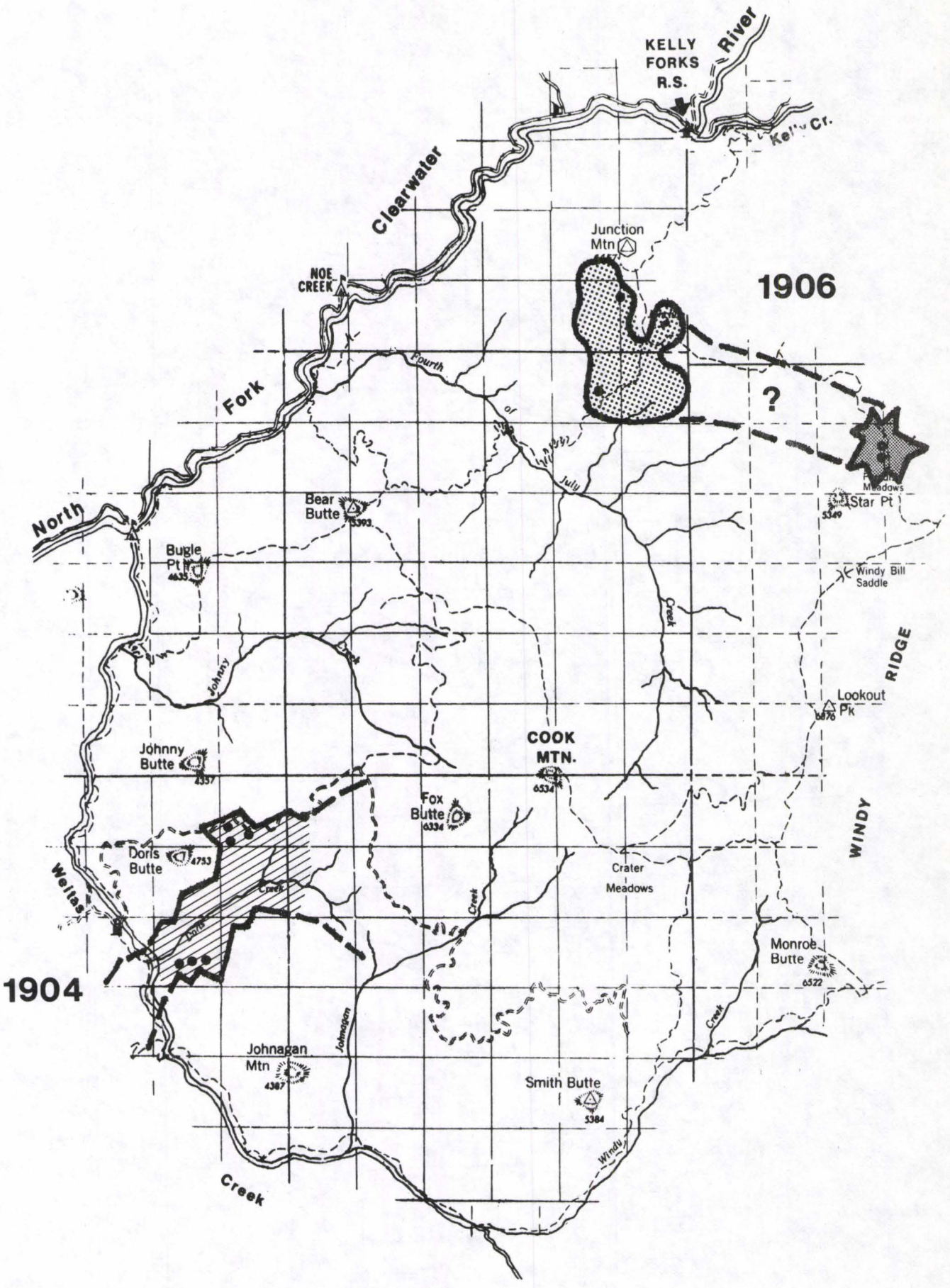
Smith Butte
5384
Windy
Creek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Bear Butte
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Bugle Pt
4635
Star Pt
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Windy Bill Saddle
Johnny
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RIDGE
Lookout Pk
6876
COOK MTN.
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Johnny Butte
5357
Fox Butte
6334
WINDY
Doris Butte
4753
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Monroe Butte
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Johnagan
Smith Butte
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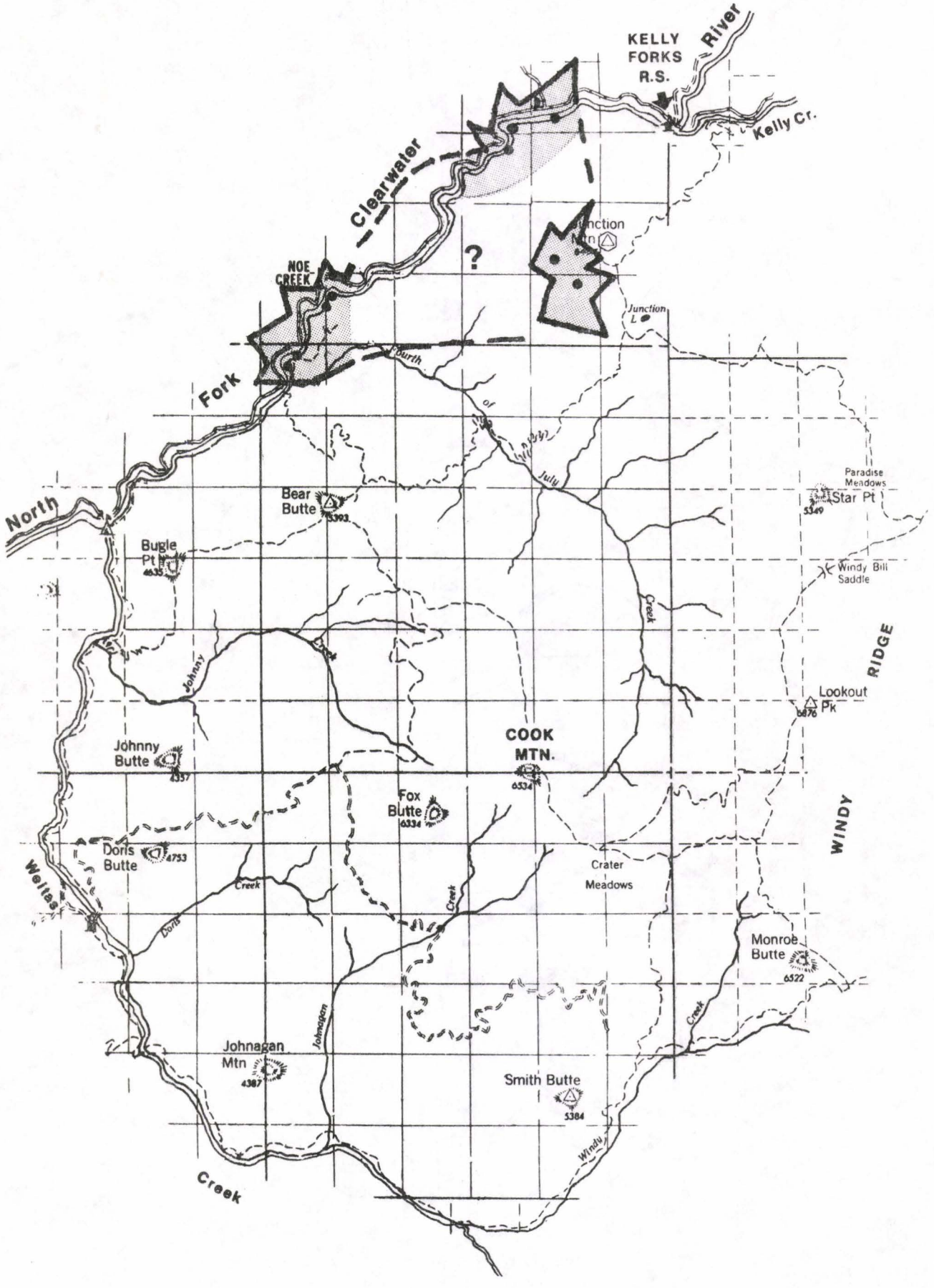
Windy
Creek

1896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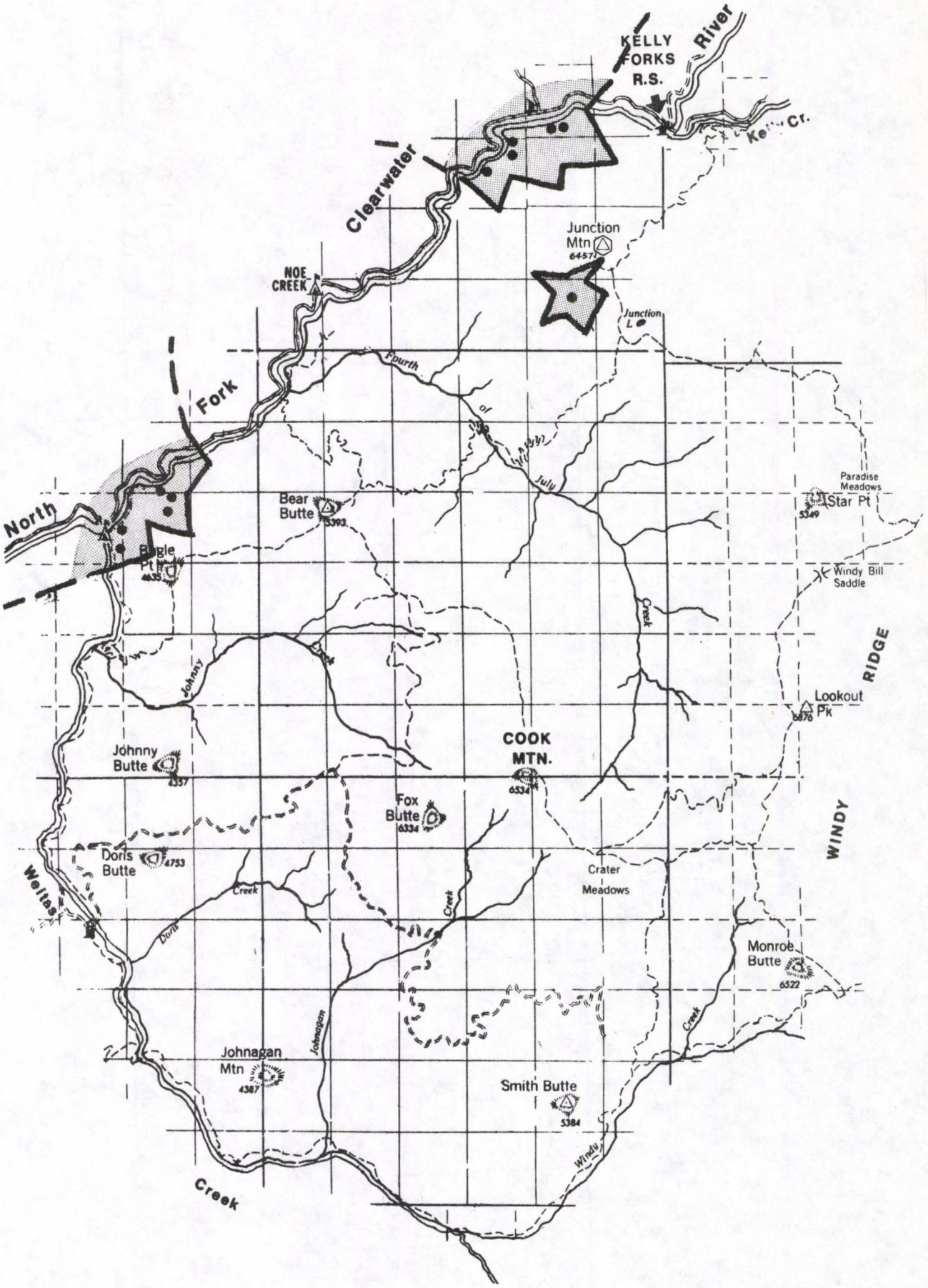
1878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Fox Butte
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Doris Butte
4753
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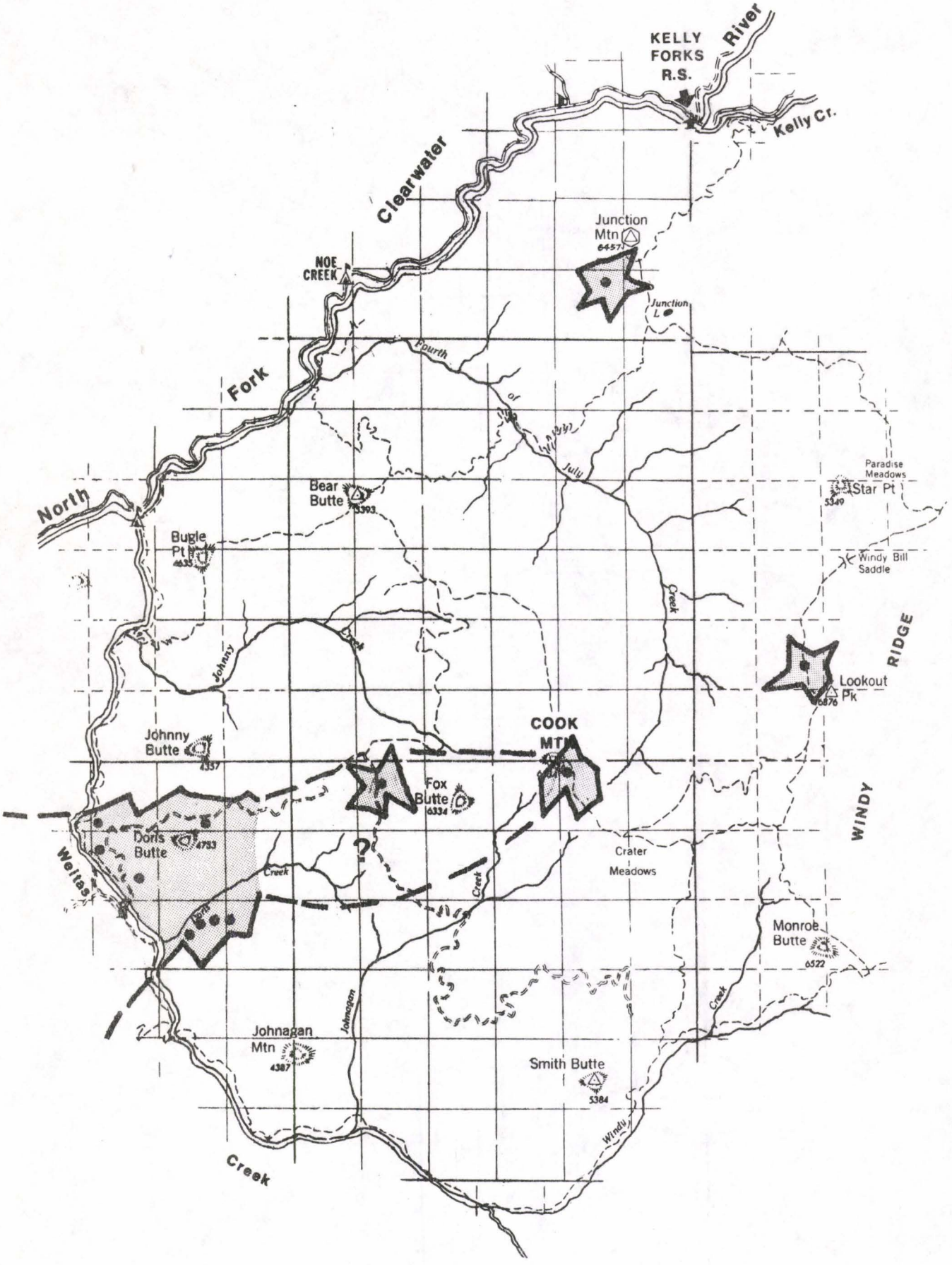
Windy Creek

1875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Fox Butte
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Doris Butte
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Crater Meadows
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Smith Butte
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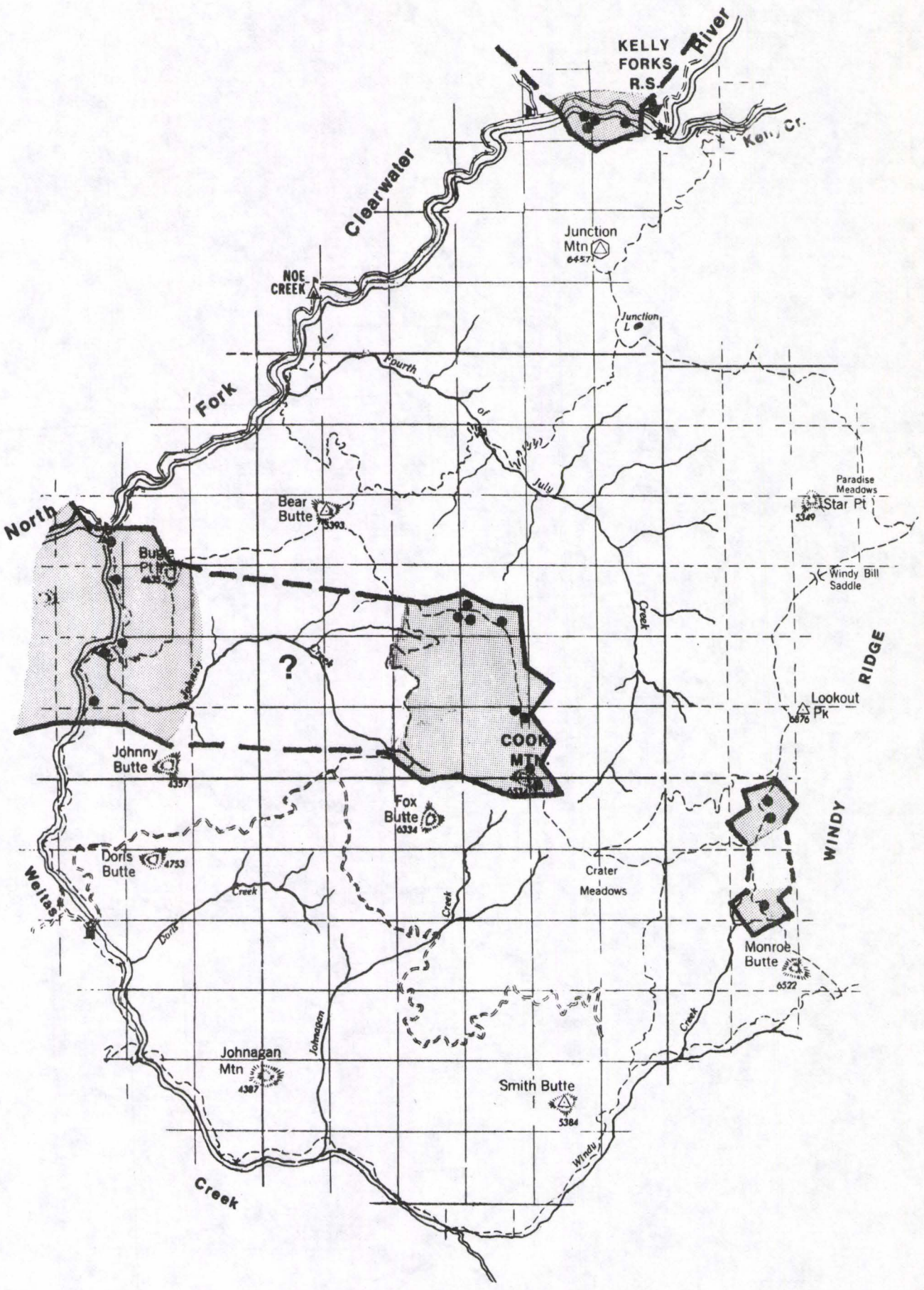
Creek

1862 ± 3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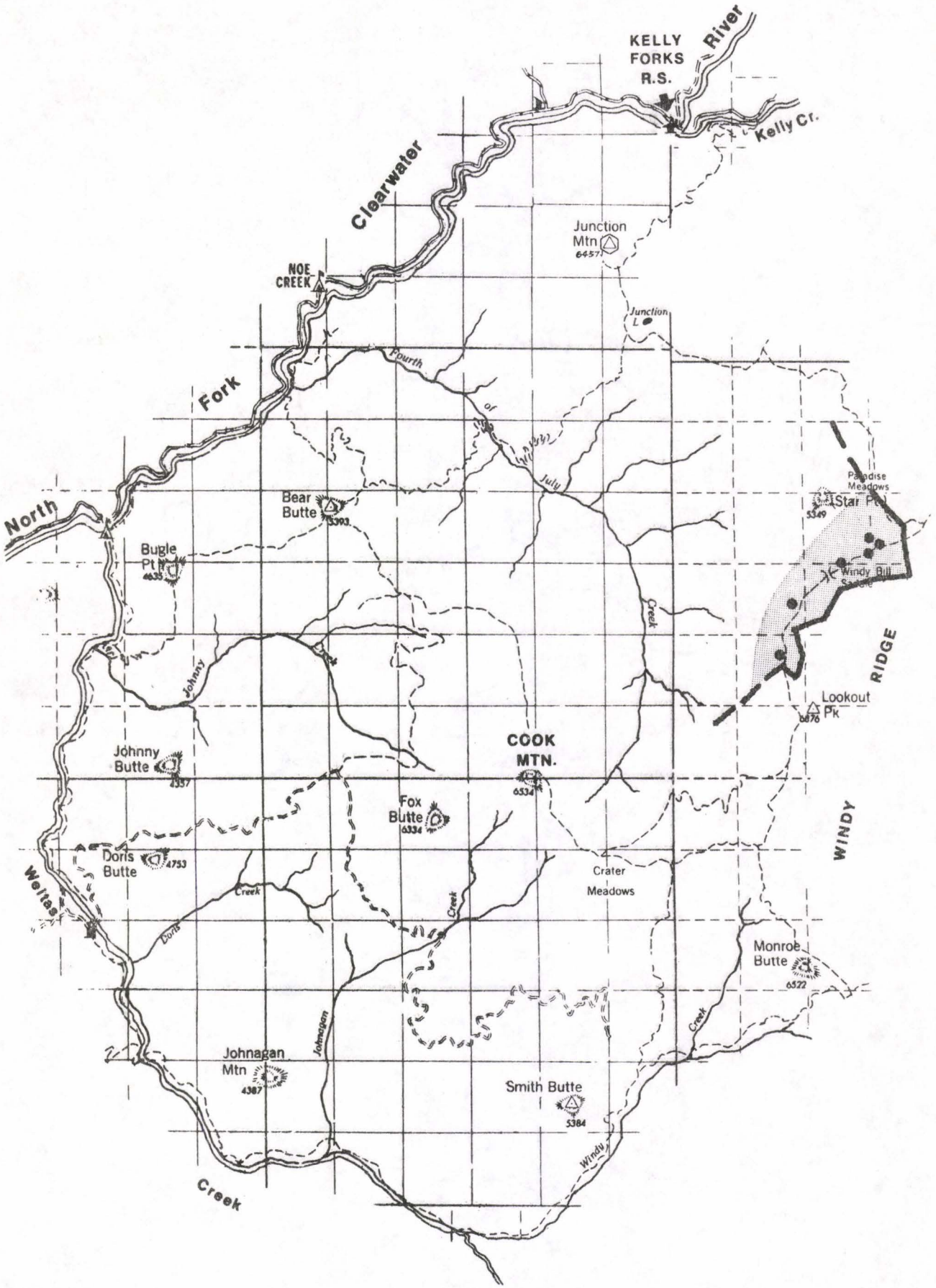
1852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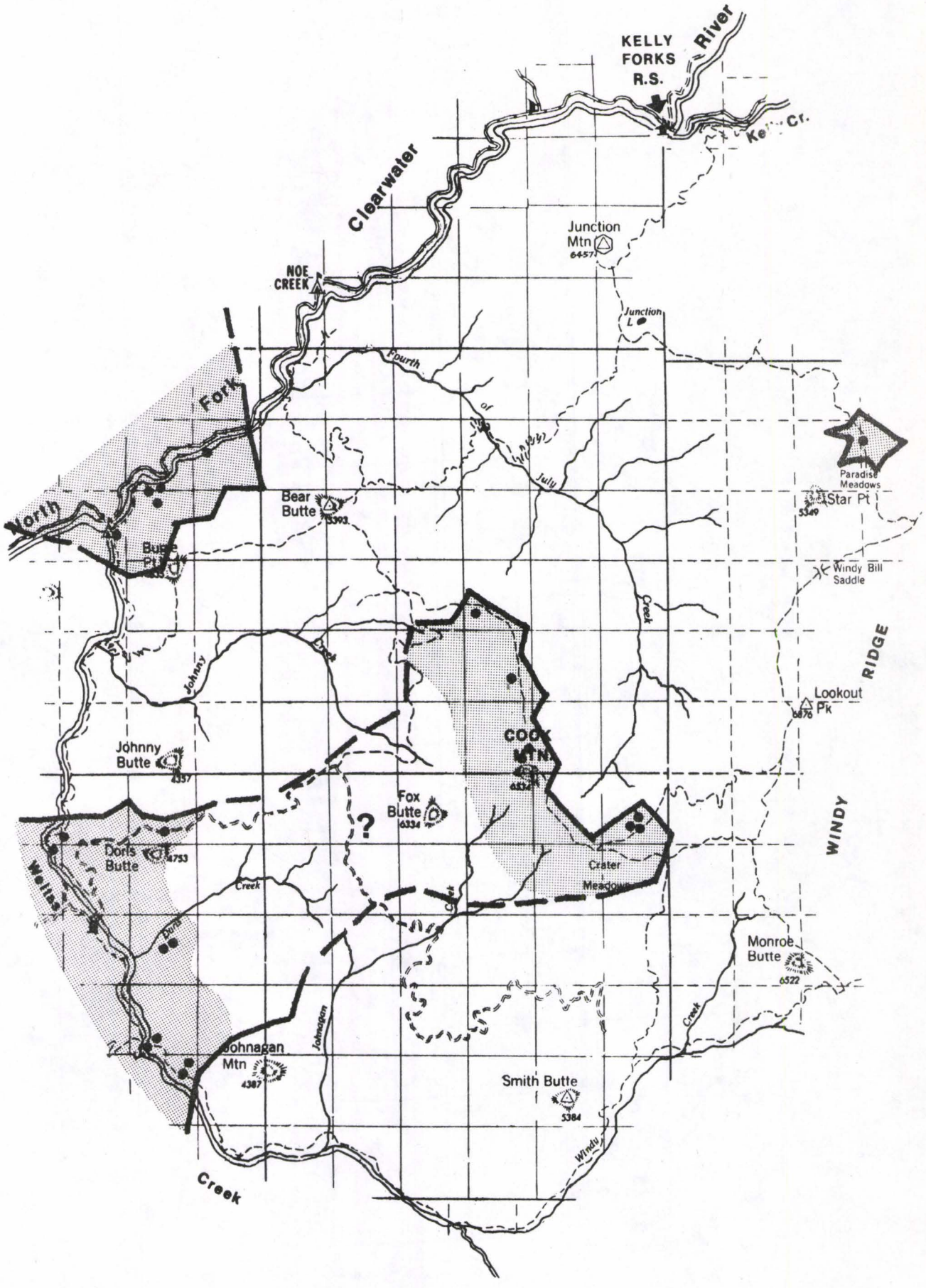
1842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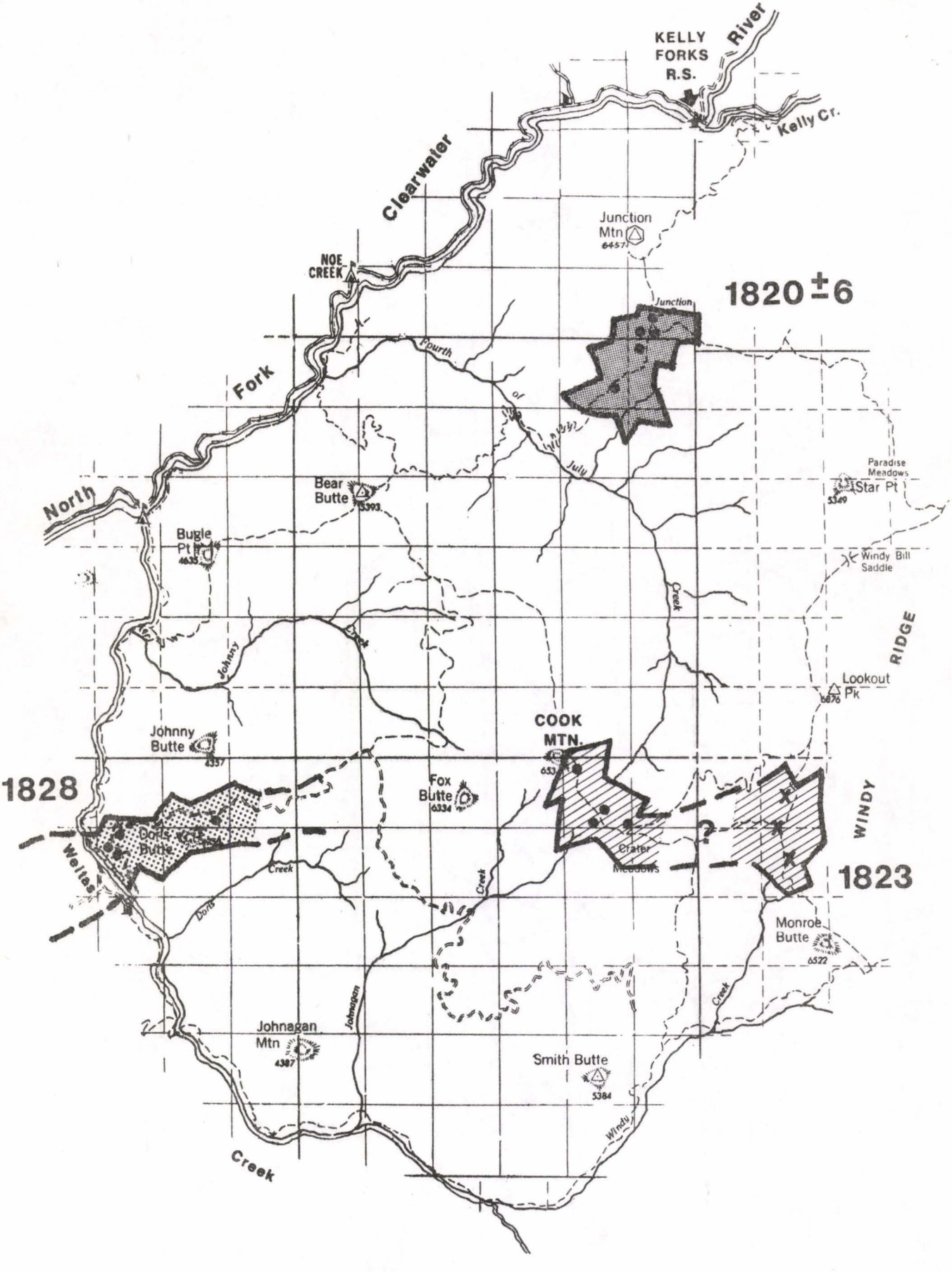
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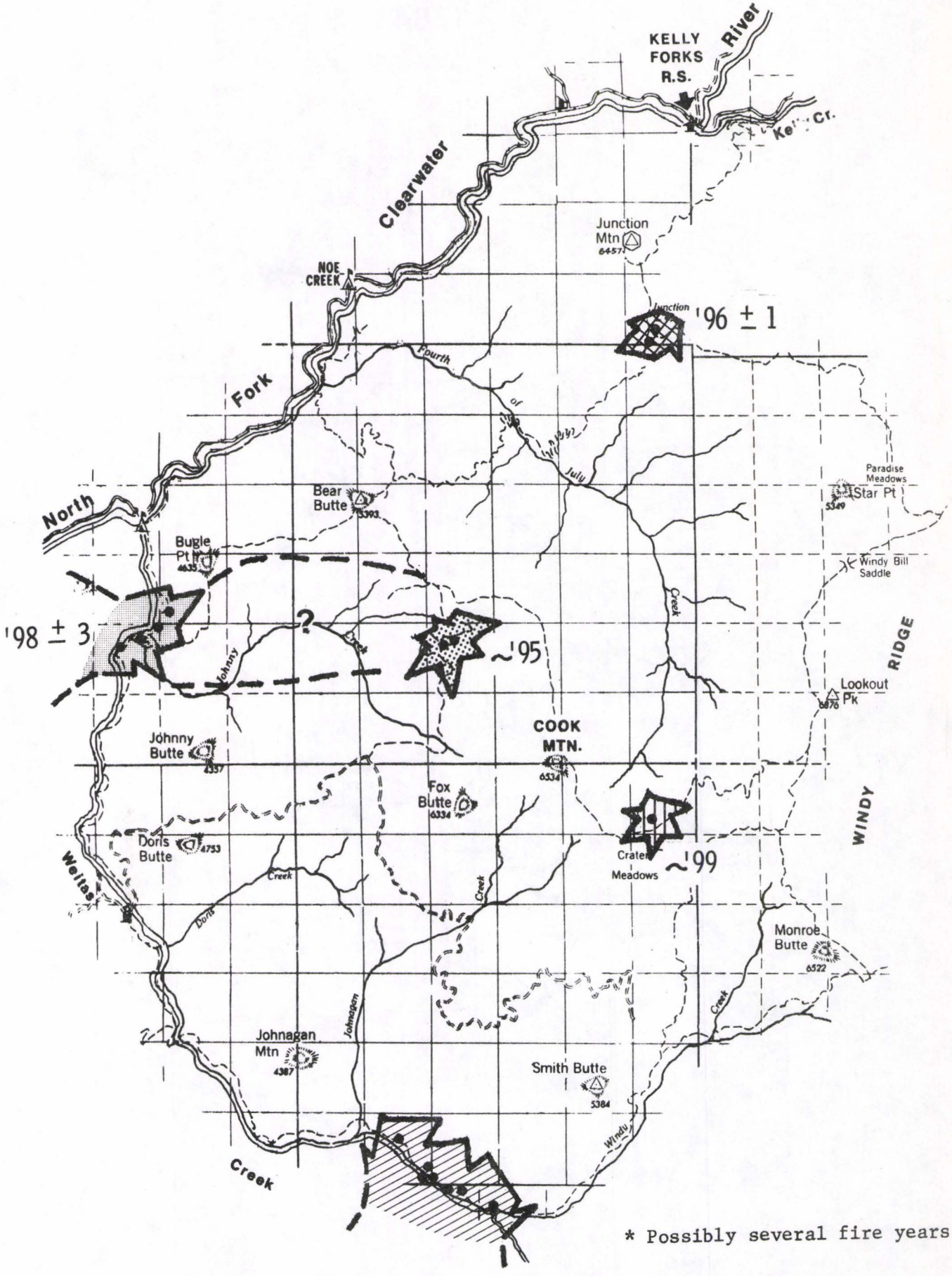
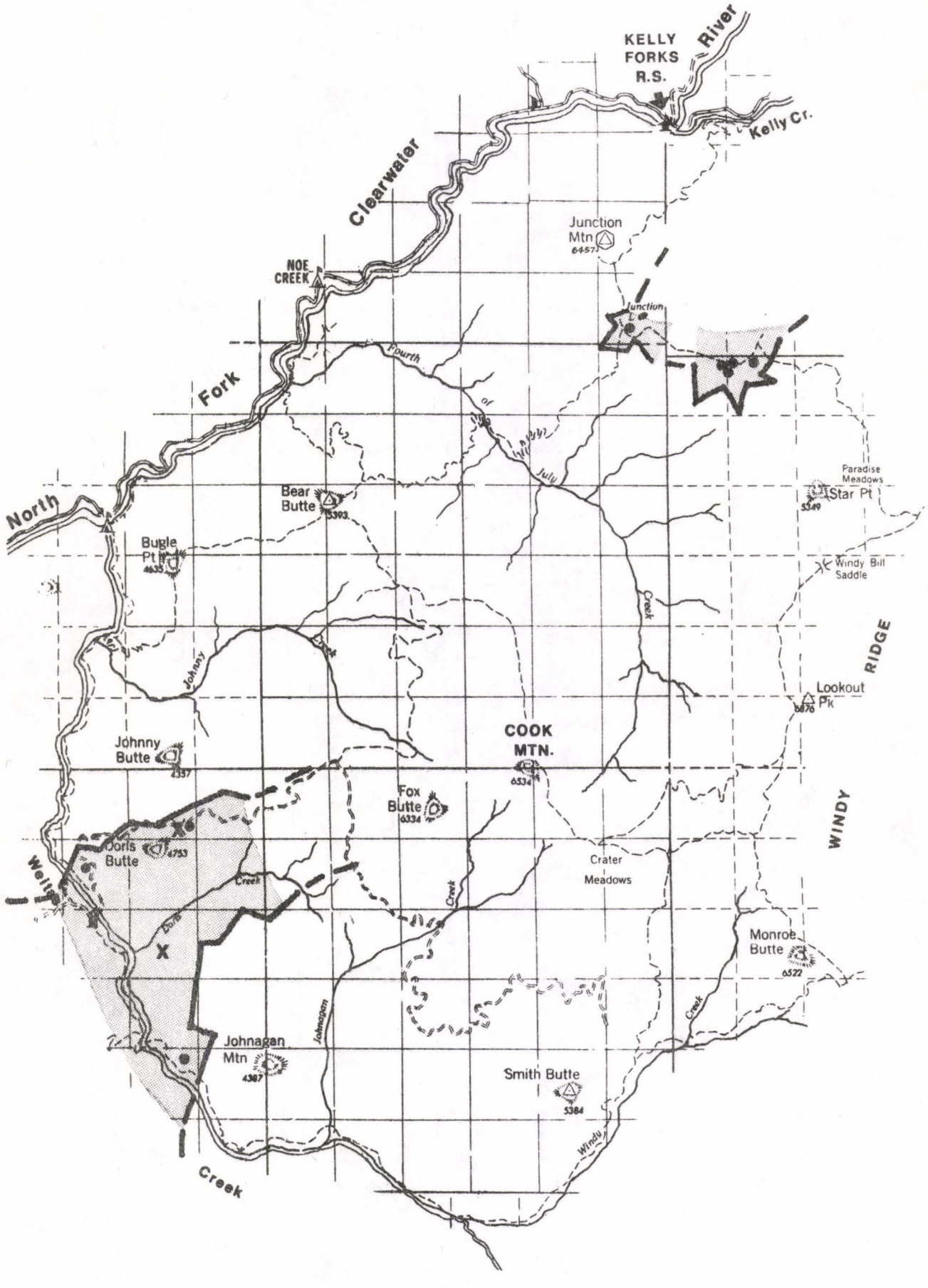
1798 ± 3*



* Possibly several fire years

1805

1784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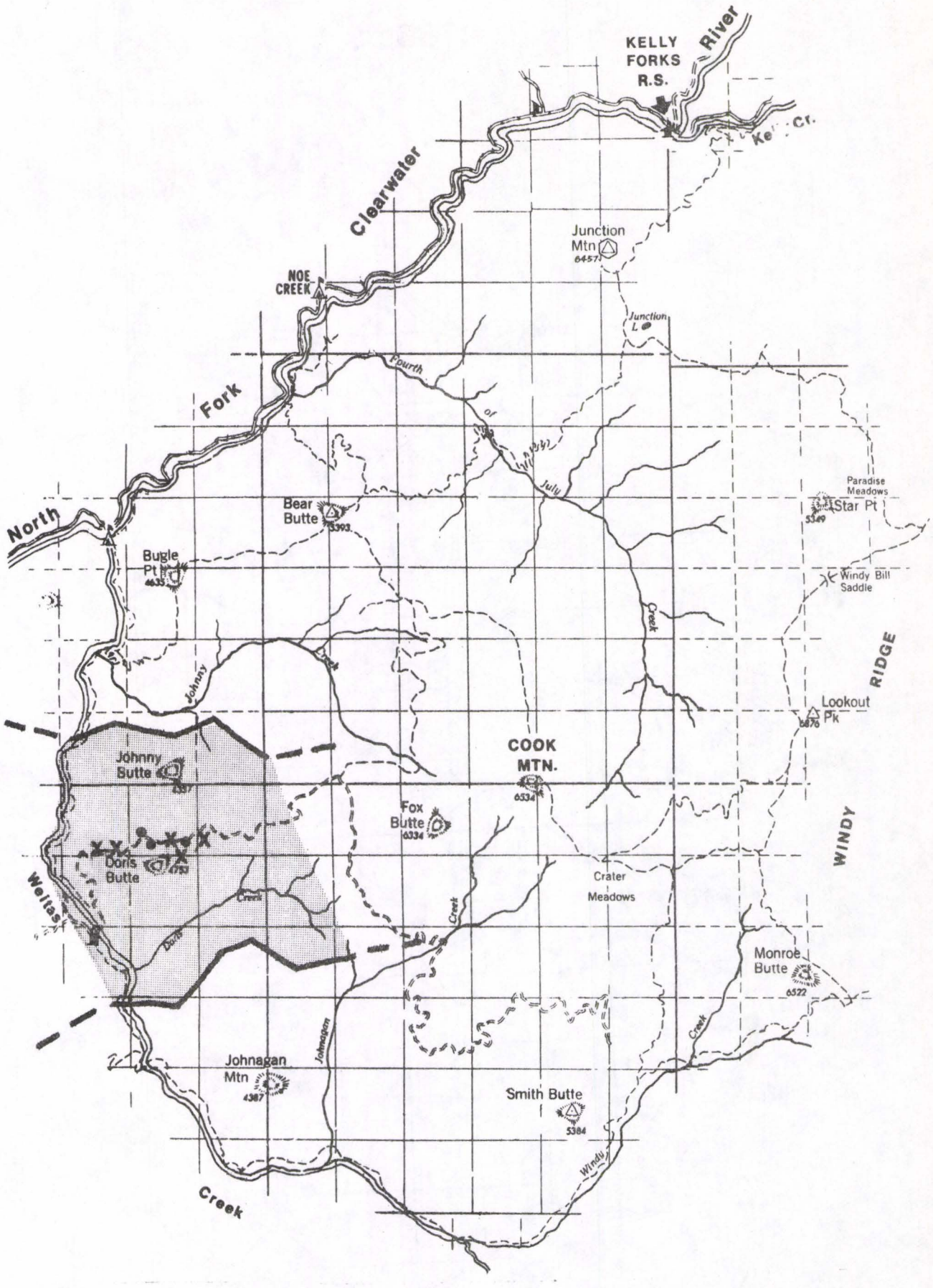
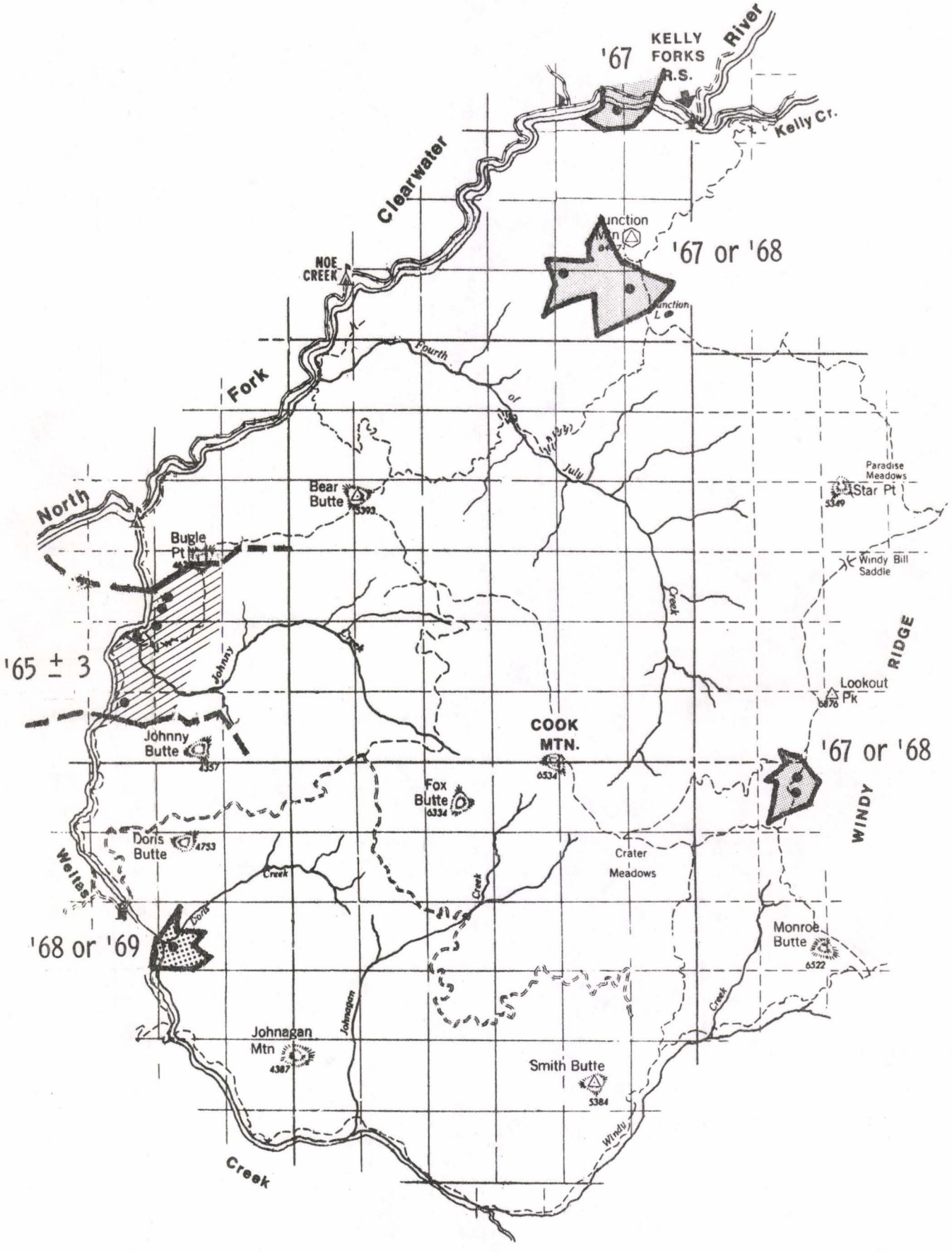
Windy Creek

1772*



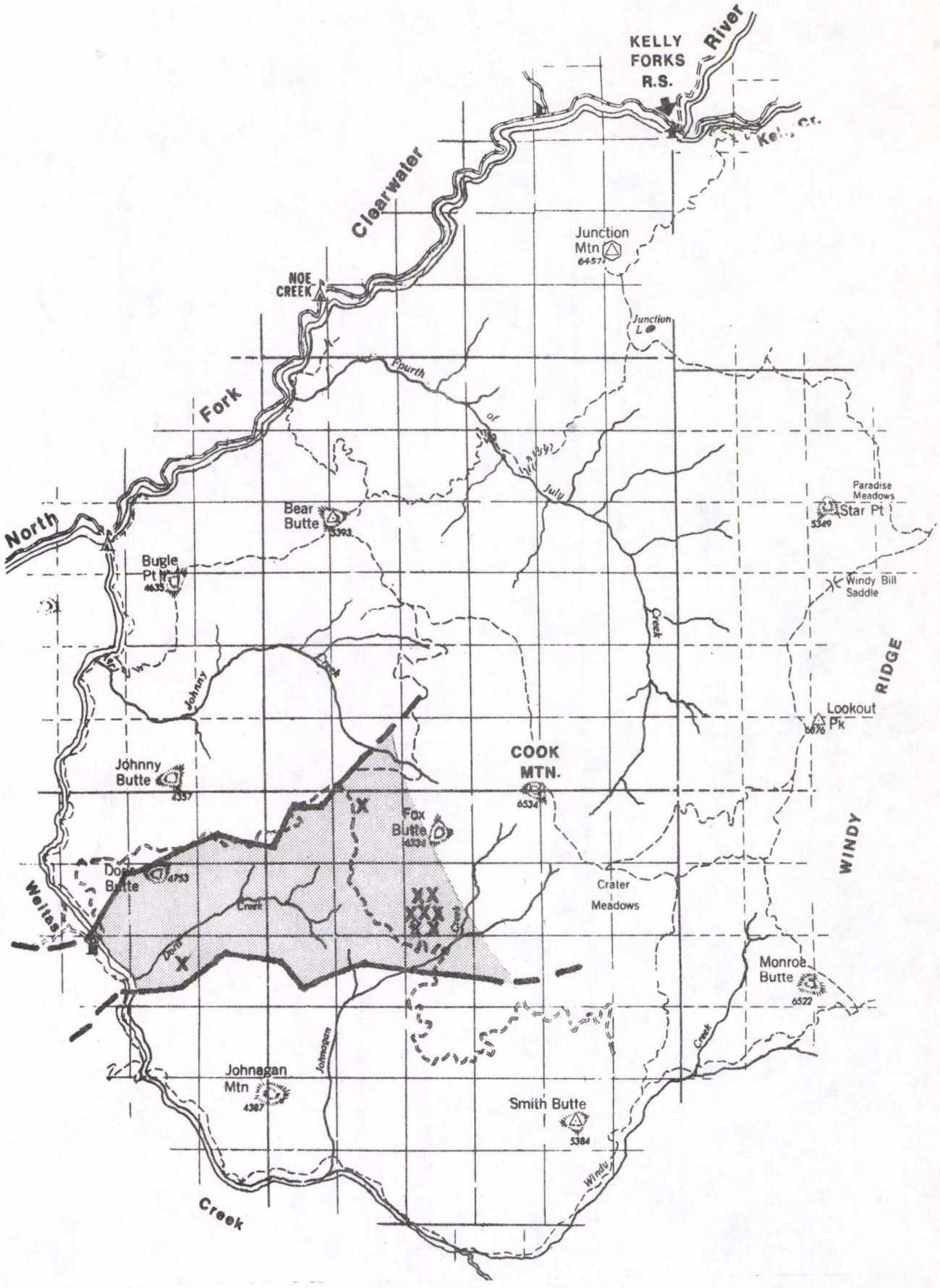
* Estimated burn margins based on locations of snag age class.

1765 ± 3*



* Possibly several fire years

1535±



* Estimated burn margins based on locations of snag age class.

APPENDIX C - GLOSSARY

Below is a brief listing of the fire history terminology used in this report (after: Stokes and Dieterich 1980):

1. DENDROCHRONOLOGIC CROSS-DATING: A method used for precision tree-ring dating; this labor intensive method is used to correct or verify fire years from a fire scar sample, by comparing the sample's annual ring patterns to the patterns obtained from an area's master tree-ring chronology, if available. (Cross-dating often is unfeasible in mesic forests such as those found in northern Idaho because of the lack of easily recognizable, drought-induced ring patterns on trees over a wide geographic area [termed "ring complacency"].)

2. FIRE-RESISTANT TREE: A particular species, and usually a pole- or larger-sized tree, with compact, often resin-free, thick corky bark and low flammability foliage; such a tree has a lower probability of being killed or scarred by fire than a fire-sensitive tree (examples of fire-resistant species are western larch, ponderosa pine, large-growth Douglas-fir, and large-growth western redcedar).

3. FIRE SCAR: The damage incurred on a lower tree bole by one fire; produced by cambial heating or direct burning resulting in death to a portion of the cambium and subsequent scar tissue formation (recognized in cross-section by a distorted, annual ring healing pattern, localized charring, or triangular shape of basal wound). (A "catface," often containing multiple fire scars, is the tree basal wound and records the history of fires scarring a tree.)

4. FIRE-SENSITIVE TREE: A species with thin bark or highly flammable foliage that has a relatively higher probability of being killed or scarred by fire than a fire-resistant tree (examples of fire-sensitive species are subalpine fir, lodgepole pine, small-d.b.h. grand fir, and small-d.b.h. mountain hemlock).

5. INDIVIDUAL FIRE INTERVAL: The number of years between two successive fires documented in a designated area, such as in one stand.

6. MASTER FIRE CHRONOLOGY (MFC): A chronological listing of the dates of fires documented in a designated area, the dates being corrected by cross-dating, if feasible. The MFC is compiled from several individual fire chronology sources (e.g., individual trees, stumps, stands, or written fire records), and is then used to determine fire frequency, mean fire interval, and other fire history parameters.

7. MEAN FIRE INTERVAL (MFI): The arithmetic average of all individual fire intervals determined in a designated area during a designated time period (both specified); MFI's commonly are calculated for large areas such as an entire study area, or for smaller sites such as stands.

8. REBURN: First defined in this study as the recurrence of fire over an area at a time when many of the fuels burned by a previous fire are available to burn a second time, and when tree regeneration is in the seedling/sapling stages.